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Other Contributor(s)	University of Hong Kong
Author(s)	Ng, Siu-hong; 吳紹康
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THE UNIVERSITY OF HONG KONG

AN EXAMINATION OF THE EFFECTS OF A NEW TRANSPORTATION NODE ON RESIDENTIAL PROPERTY PRICE IN TUEN MUN

A DISSERTATION SUBMITTED TO

THE FACULTY OF ARCHITETURE

IN CANDIDACY FOR THE DEGREE OF

BACHELOR OF SCIENCE IN SURVEYING

DEPARTMENT OF REAL ESTATE AND CONSTRUCTION

BY

NG SIU HONG

HONG KONG

APRIL 2007

Declaration

I declare that this dissertation represents my own work, except where due acknowledgement is made, and that it has not been previously included in a thesis, dissertation or report submitted to this University or to any other institution for a degree, diploma or other qualification.

Signed : _____

Name : _____

Date : _____

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Abstract

In so far as possible, transportation systems are normally laid in a direct line towards a selected destination in order to minimize the cost. This destination usually is the central business district (CBD) of a city. Most of the railway system in Hong Kong adopted the direct line principle. The railway systems in Hong Kong have long served as the major public transportation bringing people from other area to central business district. Everyone is clear on its image of fast and on time schedule when compare to other public transportation service. Usually, a premium will be added to the residential properties price which is near to the railway stations. However, this begs the question whether a non-direct railway alignment still benefit the nearby residential properties.

The development of Tuen Mun West rail station gives a chance to test what sort of impact a station with a non-direct railway alignment to the CBD has on nearby residential properties. At the same time, Yuen Long West rail station is used as a control experiment to Tuen Mun in testing the matter of railway alignment. Therefore, these two locations were studied to find out the implication of a station with non-direct railway alignment to the CBD on the nearby residential property price.

The study adopts a regression technique to examine empirically the impact of non-direct railway alignment. Two regression models are conducted respectively in Tuen Mun and Yuen Long. Data sample are collected from the transactions of the nearby residential properties to the nearest West rail station. And, EPRC (Economic Property Research Centre) is the source of data.

The results shows that the existence of a railway line does not necessarily create an increase in the nearby residential property price. In case of a non-direct railway alignment to the CBD, it shows that since the rail started its commission, the real price of the residential properties in the data sample dropped compare with the period before the railway project. On the contrary, the opposite result was found where there is direct railway alignment to CBD. This indicate that the level of detour in the railway alignment to the CBD is one of the factors determining the impact on the nearby residential property price.

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Chapter 1: Introduction

Hong Kong, one of the cities in China, is located in the Southern China coastal area facing the South China Sea. Of the territory's 1,104 square kilometers, a high population of nearly 7 millions[1] occupied less than 25% of the territory[2]. So, Hong Kong is listed as one of the highest population density cities in the world[3].

Cities with large population and high densities exert heavy demands on public transportation. This situation is found in Hong Kong. The number of passenger journeys reached 4,077 million on public transport in 2005 (Census and Statistical Department, 2006). Therefore accessibility provided by public transportation is a factor affecting people's decision on purchasing or selling the residential property.

This chapter addresses issues relating to Hong Kong population growth, the government's new town policy, together with the research question; objectives; methodology; scope of study and organization of the dissertation.

1.1 Hong Kong population

Hong Kong is a densely populated city. High rise buildings can usually be found in every developed area. This is a symbol of Hong Kong.

[1] According to the statistics released by the Census and Statistics Department, the Hong Kong Population was 6 994 500 (provisional) at mid-2006

[2] Geography and Climate, Hong Kong. Census and Statistics Department, The Government of Hong Kong SAR. Retrieved on 2007-01-10.

[3] By the List of Countries by Population Density, Hong Kong is ranked the third most population density city in the world. Hong Kong gives 6,407 people per square kilometer.

High population in Hong Kong is due to a number of historical reasons. Firstly, the significant influx of population in Hong Kong was due to the outbreak of war. There were numbers of warfare taking people from mainland China to Hong Kong. These included Sino-Japanese War; World War I and World War II. Another major warfare which pushed people in mainland China to Hong Kong was the civil war in China. When the time Chinese Communists government defeated Nationalist government, hundreds of thousands of people rushed to Hong Kong. They mainly came from commercial centers in China like Shanghai and Guangdong province. Since then, the population in Hong Kong has continued to increase. In the end of 1961, the total number of Hong Kong residents was about 3.2 million[4] and now total seven million. Figure 1 shows the population in Hong Kong from 1961 to 2006.

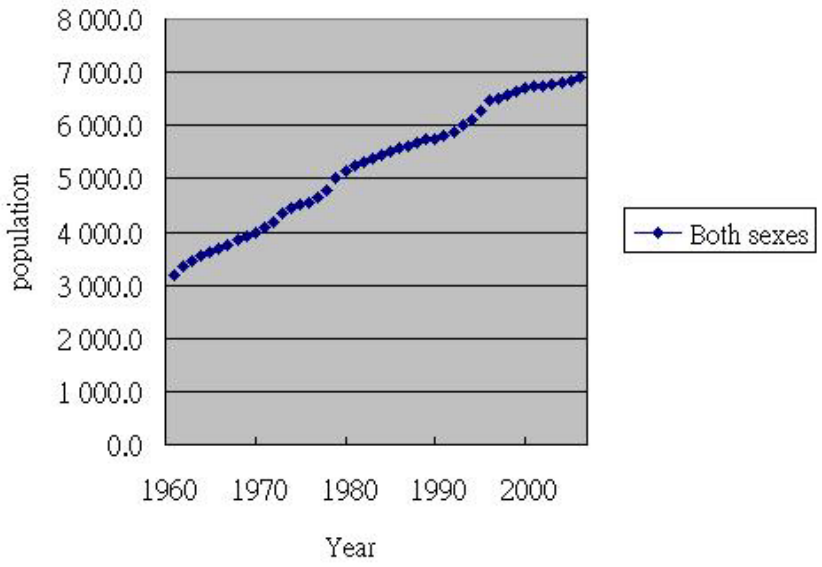

Figure 1: Hong Kong population from 1961 to 2006

Source: Census and Statistics Department

[4] According to the statistics released by the Census and Statistics Department, the Hong Kong Population was 3,195,300 at the end of 1961

1.2 New town policy and transportation

The Hong Kong government has started the new town policy in late nineteen sixties. The policy aimed to accommodate the booming population. The government chose Tsuen Wan as the first district for the policy. This was identified by Cheung (2004) --- "*The idea of new towns in Hong Kong dates back to 1959, when Tsuen Wan was designated as the first self-contained new town.*" Subsequently, Tuen Mun and Yuen Long district were planned as suitable location for developing new town.

Initially, the new town policy was designed to be self-reliant or self-contained in Tuen Mun and Yuen Long. Industrial estates have been introduced in the two districts aiming to provide job opportunities. However, the severe traffic congestion problem in Tuen Mun Road and Castle Peak Road has proved the failure of the self-reliant idea. People in these districts have to travel to urban area for work and the districts turned into a bedroom community only. So, new towns have asked for transportation infrastructure in order to cope with the huge demand in commuting to urban area.

A railway is then vital to provide a mass transportation alternative to road system to connect the new towns to the urban area. Specifically in Tuen Mun and Yuen Long districts, KCR West rail was planned to serve as another mode of mass transportation in the area. Different from the ordinary railway alignment, it was laid non-directly from Tuen Mun to urban area. Figure 2 shows the railway alignment of West rail starting from Tuen Mun West rail station.

Figure 2: the railway alignment of West rail starting from Tuen Mun West rail station

Source: http://www.centamap.com

1.3 Research question

Due to the government policy to foster new towns at some distance from older urban area, large population has being driven out into New Territories (rural area). Having driven the population, works as well as job opportunities are still in urban district. As a consequence, population of new towns heavily depends on public transportation.

Railway has being served as a major public transportation to fasten rural and urban area in Hong Kong. A remarkable importance of railway is noted. Previous studies found a relationship existed between railway and regional residential property price. As a matter of construction cost and railway efficiency, the rail track is usually laid directly to the preferred destination. So, the introduction of non-direct railway alignment in the West rail is found interesting. "*Whether there is any effect on the*

prices of residential properties adjacent to a newly developed railway station which located on a non-direct alignment to the CBD" becomes the research question of the study.

1.4 Objectives

In order to answer the research question, there are altogether four objectives in this dissertation:

- To study the background of West rail and two subject district, Yuen Long and Tuen Mun
- To examine the studies about the relationship between railway station and the residential property price through desk top searching.
- To collect residential property transaction data around Tuen Mun and Yuen Long West rail station
- To explain and compare empirically the effect of the two West rail station, Tuen Mun and Yuen Long, on the adjacent residential properties

1.5 Methodology and scope of the study

The consequences of the non-direct railway alignment on the nearby residential property price are to be assessed by using the hedonic price model. The model was proposed by Rosen in 1974 for doing regression in real estate market. The use of this model, therefore, is to assess the particular contribution of each attribute of the residential bundle to market value. By studying the variation of the implicit real

price of residential properties which are next to the subject railway station against the time, a comparison of the different impact of the subject railway station in different phases of the railway project will be carried out.

The scope of the study will be focused on residential properties next to the two West rail stations namely Tuen Mun West rail station and Yuen Long West rail station. The real price of residential properties in every transaction within period 1995 to 2006 will be studied in order to evaluate the variation of residential property real price in different period.

1.6 Organization

This dissertation will be divided into 6 chapters. The first chapter is the introduction to the study. In the second chapter, the subject districts and railway will be introduced and associate with the introduction of Hong Kong residential property market. The second and third chapters is the literature review in relation to land value theory; impacts of railway on the residential property price; the use of hedonic price model and the residential property price attributes will be included. In chapter 4, the methodology and data collection for the study will be explained. The hypothesis of the study will also be presented. Chapter 5 is the results of the empirical result of the study and the analysis part of the study. The empirical result will be examined in response to the research question of the study. Lastly, chapter 6 will conclude the findings, pointing out the limitation of the study as well as the area for further study.

Chapter 2: Background

The Hong Kong government has conducted two railway development studies (RDS) (Highways Department, 2000). They were studied the railway network to serve HKSAR to meet the present and future demand. Indeed, West rail is a key component in this network. It is used to link north-west part of New Territory to the urban area.

The two furthermost districts in north-west New Territory are Tuen Mun and Yuen Long. The final layout of the rail track of West rail passes through these two areas. Figure 3 shows the position of Tuen Mun district within Hong Kong Special Administrative Region (HKSAR).

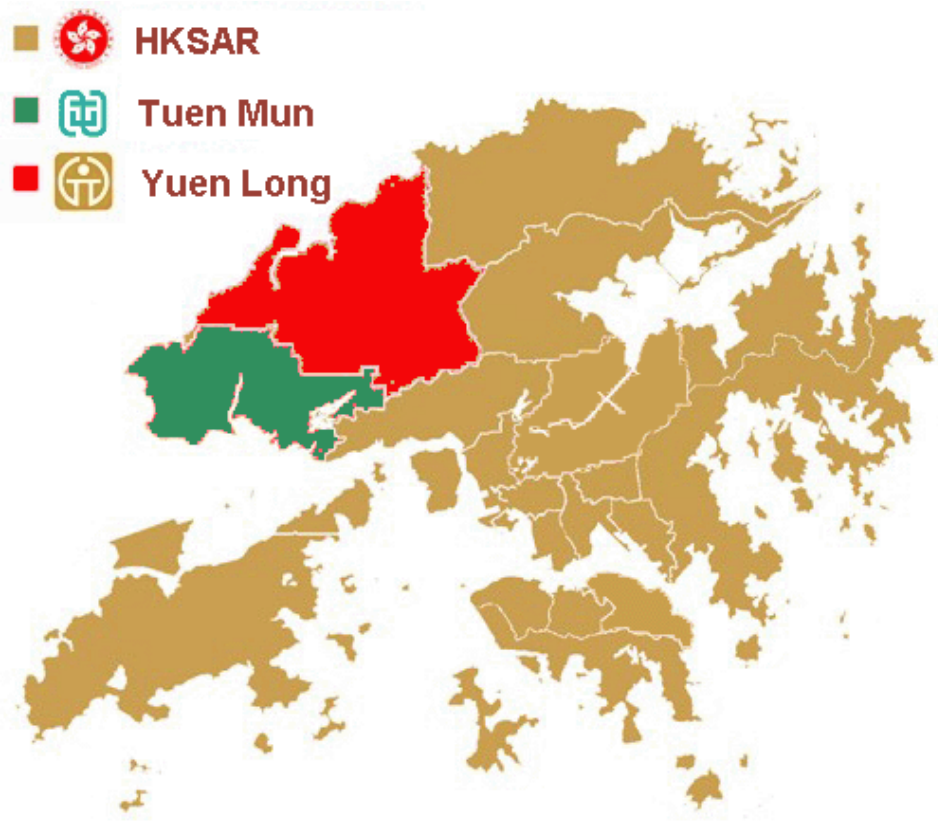

Figure 3: Tuen Mun and Yuen Long location within HKSAR

Source: http://en.wikipedia.org/

This chapter describes the background to the study. The population as well as the geographical location of Tuen Mun and Yuen Long district will be covered. Then the chapter will give a brief introduction to the Kowloon-Canton Railway Corporation (KCRC) and the West rail project. Lastly, an overview of Hong Kong residential property market will be introduced.

2.1 Tuen Mun

From the report of the Census and Statistic Department (2006), the population in Tuen Mun district in 2006 is 502,035 people, 7.3% of the total population of Hong Kong. Of the area 84.45km^2, Tuen Mun district gives a population density of 5,788 per km^2.

Tuen Mun has been earmarked as one of the new towns in Hong Kong designed to accommodate the redistributed population from the order urban area. It is situated in the north-west part of the New Territories. More than half of the district boundary is facing the South China Sea.

Two adjacent districts are Yuen Long and Tsuen Wan respectively. The geographical location of Tuen Mun district does not allow its to residents travel to the east of New Territories of Hong Kong directly since the landscape of Tai Mo Shan and Tai Lam Country Park formed a natural barrier. As a result, Tuen Mun district is disadvantaged in terms of transportation. People in Tuen Mun either go north (Channel 1), which by-passes Yuen Long district to other locations, or east (Channel 2) to their destination via Tsuen Wan district. If using the former channel to go to the

urban areas like Tsim Sha Tsui or Central in Hong Kong Island, requires a big detour. Figure 4 shows the geographical location of Tuen Mun district (the green shows the area of country park and mountain area).

Figure 4: Geographical location of Tuen Mun district

Source: http://www.centamap.com

2.2 Yuen Long

The population in Yuen Long district is slightly higher than that in Tuen Mun. It has 524,129 people within 138.43 km^2 area. The population density in Yuen Long is 3,786 people per square kilometer.

Yuen Long, somewhat later than Tuen Mun, was also designated one of the new towns in Hong Kong. It located in the Yuen Long Plain which has been developed into mainly residential use. In a similar manner as Tuen Mun district, the

government has introduced an industrial estate adjacent to the residential zone with the same reason of achieving a self-reliant district.

In the past, Yuen Long relied on transport links in Tuen Mun Road for connection to the urban area. After the Tai Lam Tunnel was opened to traffic on May 1998, the overloading condition in Tuen Mun Road was eased and provided more direct route to the urban area. Figure 5 shows the geographic location of Yuen Long district and the major pathways connecting to the urban area.

Figure 5: Geographical location of Yuen Long district

Source: http://www.centamap.com

2.3 KCR West rail

Kowloon-Canton Railway (KCR) is part of the railway network in Hong Kong which plays a vital role in carrying people from place to place. The Kowloon-Canton Railway Corporation (KCRC), which is fully owned by the Hong Kong government, runs the KCR operations.

Immediately, after the Second World War and during the 1950's and 1960's, there were lots of immigrants from Mainland China migrating to Hong Kong and thus Hong Kong population raised dramatically. Because of relatively poor transportation infrastructure, the majority of the population lived in the urban area (Kowloon and Hong Kong Island). Overcrowded population in the older urban areas boosted the Hong Kong government introducing a new town programme in the mid-1960s. Tuen Mun village and the market town of Yuen Long were then designated as new town for expansion. In 1988, a light rail system was developed to connect the two towns. However, it was still inconvenient for the people who lived in these two new towns to commute to the urban area for work. For those who wanted to go the urban area from Yuen Long or Tuen Mun, they first travelled by means of road transport to Tsuen Wan station of Mass Transit Railway (MTR) which was the closest MTR station to these new towns. Then they used the MTR network to reach their destination. The Government's Railway Development Study (RDS) looked at the issues of traveling convenience. Wade (2006) notes "*…the overall network would comprise two strategic rail corridors, an enhanced easterly one using the existing KCRC line (East Rail) as a backbone and a new western corridor through the North-west New Territories (NWNT)*…" The Western Corridor Railway (the previous name for West rail) was put forward in the proposal. In 1995, both Mass Transit

Railway Corporation (MTRC) and KCRC were invited to submit their plans for the rail operation and development. The KCRC, was selected to undertake the West rail development.

Originally, KCRC proposed to locate the West rail terminal station in Tin Shui Wai new town. However, residents in Tuen Mun requested a railway connection within the center of the town. A railway loop connecting to Tuen Mun was then finalized as the final railway alignment of West rail. Figure 6 shows the current KCR West rail map.

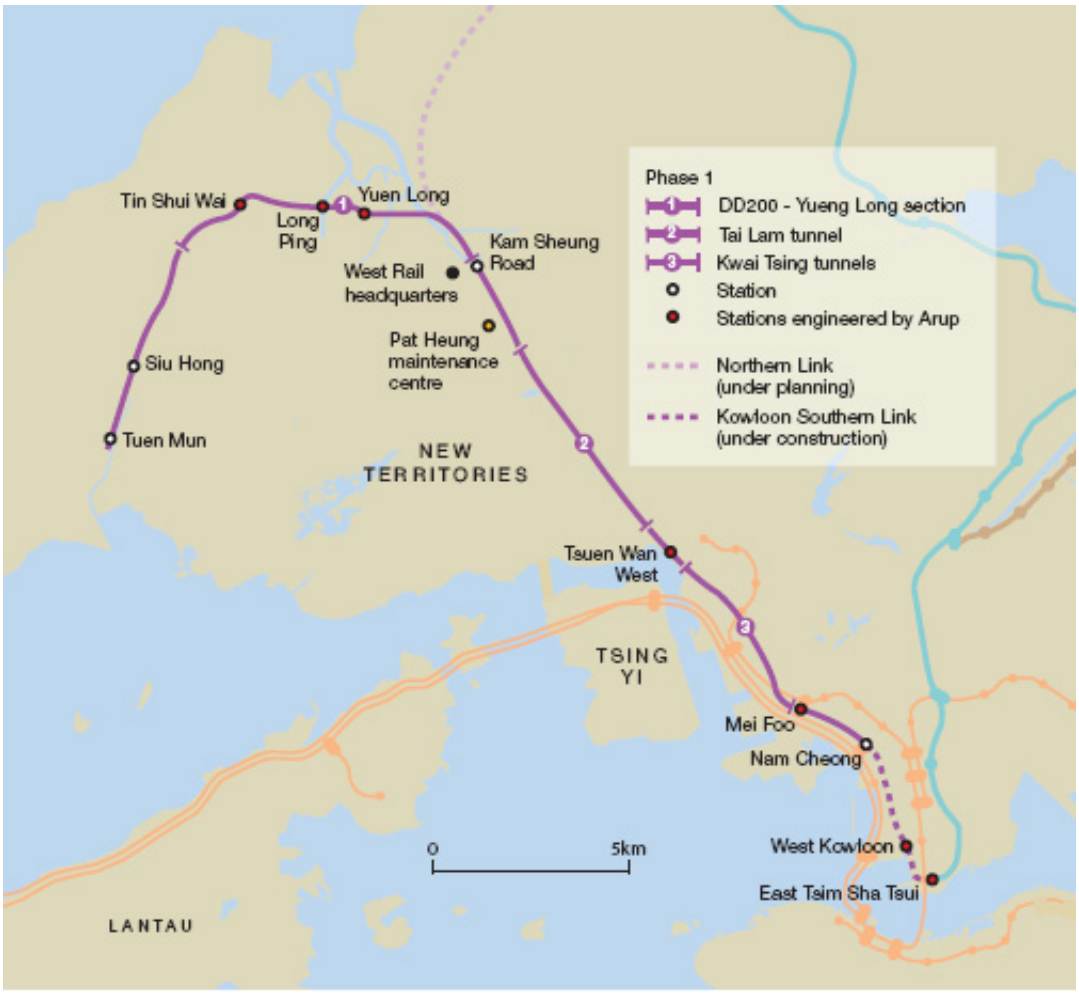

Figure 6: Current KCR West rail map

Source: Wade (2006)

At the beginning, the West rail was designed with a cross-border station and to be connected with the East rail in Tsim Sha Tsui. For reasons of financial budgeting, the KCR divided the whole West rail project into phases. In phase one, the railway from Tuen Mun station to Nam Cheong Station was built (the existing route, see figure 6). Phase two construction for the cross-border service and extending the terminus to Tsim Sha Tsui were deferred.

The whole journey of the West rail is about 30.5km. It links the north-west part of the New Territories and West Kowloon. The West rail is the most efficient means of transportation for commuting to the urban area by the growing population in the north-west part of the New Territories to the urban area. Reports from Wong (2002) "West Rail has nine stations and passing through six major districts, namely Sham Shui Po, Kwai Tsing, Tsuen Wan, Yuen Long, Tin Shui Wai and Tuen Mun. It has interchange provision to three major railway systems. It links to the Mass Transit Railway (MTR) Tung Chung Line at Nam Cheong Station, to the MTR Tsuen Wan Line at Mei Foo Station, and to the Light Rail System at Yuen Long, Tin Shui Wai, Siu Hong and Tuen Mun stations" (See figure 6).

The West rail uses the existing Light Rail Transit (LRT) network and the KCR feeder bus services to extend the covering area. The LRT is designed to link the three major new towns of Tuen Mun, Yuen Long and Tin Shui Wai. There are totally 68 stops for LRT, which serves mainly the town area of the new towns. The KCR feeder bus services works in a similar way to the LRT but covers a wider area including Tsim Sha Tsui east, Tuen Mun Rural area etc..

2.4 Hong Kong residential property market

The land tenure system in Hong Kong, for all its land except the St. Johns Cathedral in Central district is leasehold. The Hong Kong government implements a high land price policy which serves as one of the major income for the government and indirectly creates high property prices.

Due to the limited land resource, the residential properties in Hong Kong are predominately high rise. They are mainly apartment units which turning part of a residential high rise building blocks in estates.

The residential property market in Hong Kong is interrelated with a lot of factors. In terms of macro-economics, interest rate as well as economic environment such as inflation; stock market performance and the government intervention affect the general residential property market status.

As a mortgage is the usual means for people in Hong Kong to purchase a residential property, the interest rate in Hong Kong becomes one of the major factors affect the residential property market. Fluctuation of interest rate may alter the intention to buy a residential property in Hong Kong.

Another factor is the economic environment in Hong Kong. Firstly, inflation may prohibit current expenditure, so, residential property market investment may increase. Secondly, by observing the recession period in 1998, the residential property market turned down at the time of economic recession. The stock market is interrelated with the residential property market in Hong Kong. Lastly, government interventions also

affect the economic environment. For example, the Tenant Purchase Scheme, which was announced on 8th December 1997, destroyed the demand for Home Ownership Scheme (HOS) housing and calculated to the collapse of the entire housing market.

There is wide variety of residential properties in Hong Kong. The Rating and Valuation Department (RVD) provides an outline to classify residential property according to the gross floor area (GFA). Table 1 shows the classification of residential properties in Hong Kong by RVD.

Classification	GFA of property
Class A	<40.0m^2
Class B	40.0 m^2 – 69.9 m^2
Class C	70.0 m^2 – 99.9 m^2
Class D	100 m^2 – 159.9 m^2
Class E	>159.9 m^2

Table 1: Classification of residential properties in Hong Kong

Source: Rating and Valuation Department

The Rating and Valuation Department is also responsible for providing a property index on Hong Kong property market. One of the indexes provided by RVD is the price index for the Hong Kong property market including residential property; commercial property for both retail and office and industrial property. It shows the fluctuation of the property price in Hong Kong. Figure 7 shows the price index for Hong Kong property market from 1997 to 2006.

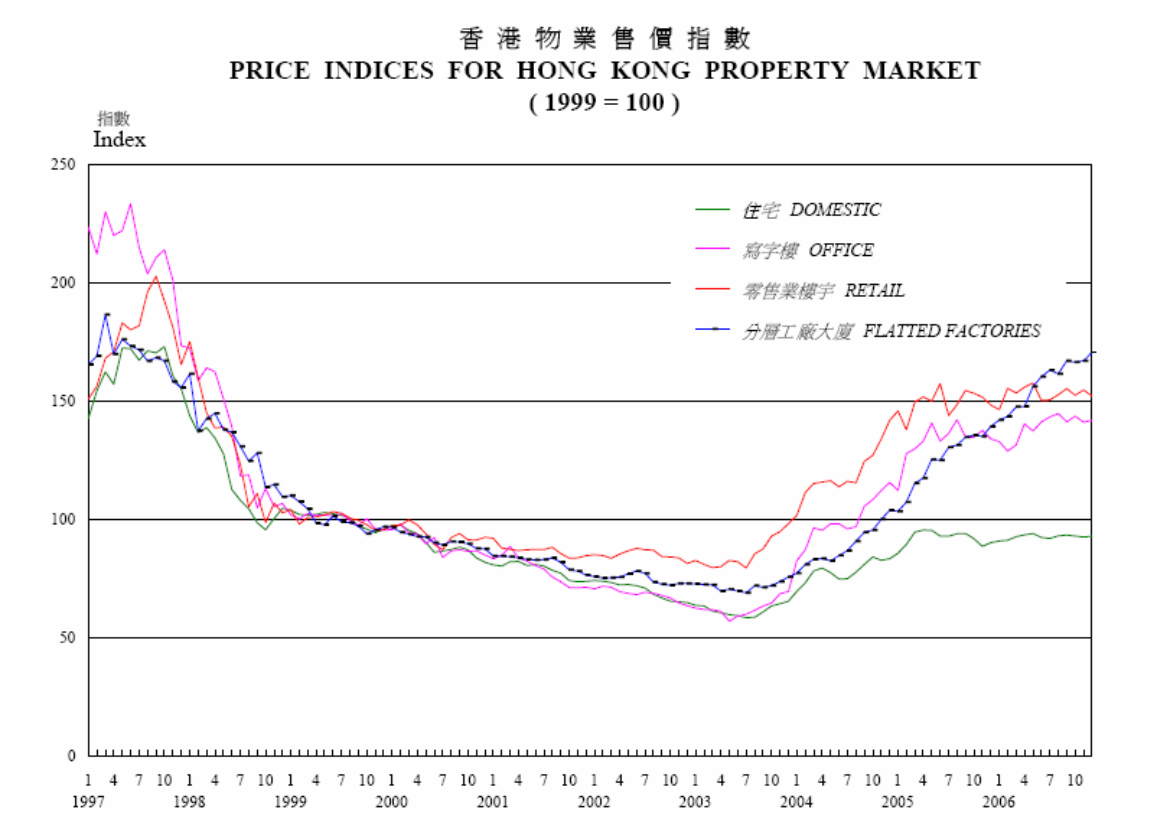

Figure 7: Price Index for Hong Kong Property Market from 1997 to 2006

Source: Rating and Valuation Department

Usually the price index is used as an indicator to show the level of price of a property. And for the research purposes, it is commonly used to discount the price of a property to a same year for comparison, thereby, the time effect can be disregarded.

Chapter 3: Literature review

The relationship between the location of a residential property and its price has long been a very popular topic. The most popular factor linking with the land value for discussion is transportation. More specifically, the topic of the relationship between railway and the residential property price is often seen. While much research has addressed this area, the physical nature of the railway has remained largely ignored in pointing out the effect of railway to the residential property price. Review is then studied from the past theories to the latest findings in relation to location and transportation of residential properties to its price.

This chapter will be divided into four parts. The first part is dealing with the relationship between land value and its location. The second part is about the effect of railway on property price. More detail empirical findings will be presented. The third part in this chapter is the review on hedonic pricing model. And the last part is concerning about the property price attributes which supplement the selection of independent variables in conducting the hedonic price model.

3.1 The relationship between land value and its location

The research about the relationship between land value and its location can be traced back to early nineteenth century. David Ricardo in Hartwell (1971) introduced the relationship between the rent of an agriculture land and the variable factors affecting the production. Ricardo wrote the book "*On the principles of Political Economy and Taxation"* in 1817 aiming to define, firstly, the laws which regulate distribution;

secondly to understand the effect of the progress of wealth on profits and wages and thirdly to trace satisfactorily the influence of taxation on different classes.

Focusing on the first part which is about the law which regulates distribution, Ricardo in Hartwell (1970) suggests that rent is levied by the landlord when there are competitive advantages regarding to production on a particular piece of land. It implies that as the farmers compete with each other for the more productive land where more benefit can be received by the farmer, the land closer to the market and with a lower transportation cost enjoys a higher rent to that distant to the market.

Similar topic against the agriculture land is conducted by Von Thünen in 1826. Von Thünen in Hall (1966) put forward the agriculture location theory. He assumes “the city is an isolated state which is surrounded by unoccupied wildness, the land within the stated is completely flat and the quality of the soil and the climate is consistent throughout the state. Farmers in the isolated state transport their own goods directly with the shortest distance to the market via oxcart and they act to maximize profits”. Consider two factors namely production cost and transportation cost per unit production, market price per unit output remains constant as they are in the same quality, and the production cost varies from distance as cultivation intensity varies is suggested by Von Thünen. The higher cultivation intensity which cost more in production will be found near the market. Table 2 shows the cost data for grain at varying distances from the market:

Grain	Thalers per load			Total
	Production costs	Transport costs	Land rent	
0 miles	30	0	10	40
5 miles	25	10	5	40
10 miles	20	20	0	40

Table 2: the cost data for grain at varying distances from the market

Source: Von Thünen's Isolated State,1966, by Von Thünen, translated by Carla M. Wartenberg, edited with an introduction by Peter Hall

Land rent is a residual for the production cost. In other words, it expresses the saving in the other two sets of costs (production costs and transport costs). Complementary relationship between the transportation cost and the profit per unit output after deducting the production cost is suggested by Von Thünen in Hall (1966).

Land rent, therefore in line with the potential profit to be generated by the agriculture land, but declines when the distance to the nearest market increases. "*For every crop cultivated under a given system there will be a certain level of gross output per acre, costs per acre, and a range of farm prices depending on the transportability of the crop.*" Von Thünen in Hall (1966) uses the above simplified condition to deduce his theory in agriculture location where most intensive agriculture activities will be located near to the market while less intensive one will be located relatively far away from the market.

Nevertheless, Von Thünen in 1826 gives a preliminary image to people about the relationship between the location rent to the transportation cost.

Richard M. Hurd (1924) studies the cities in the United State of America. From his observations, cities in the past were located largely related to the geographical superiority which can satisfy the resident's first need such as water and wood. In modern age, geographical superiority of a location no longer be the first consideration where a city to be located. A city is relied on the transportation facilities especially the railroad, according to Hurd (1924), which superseded all other land trade routs. He then adds on top of the previous writers relating to the topic of the relationship between land value and its location. He applies the theory of economic competition to his research about the agriculture land in the urban area. He draws people attention on the issue that different land uses will competes against another and the land goes to the highest utilization. Hurd (1924), on other hand, points out that city growth consists of movement away from the point of origin whatever the type of a city. They move in a direction along the railroad and others to form the framework of cities. He finds that "*Value by proximity responds to central growth, diminishing in proportion to distance from various centers, while value from accessibility responds to axial growth, diminishing in proportion to absence of transportation facilities*," The change which diminishes in proportion from the city center is applicable to the whole area of the city. He concludes the value of a site depends on the nearness to the market. To elaborate, value of a site or a piece of land, using rent as a proxy, dissipates in the form of transportation cost as the direct distance between the site and the market increase.

Haig (1926) reinforces the previous studies on the relationship between the land value and the location. He uses a simplified environment to demonstrate his theory. He ignores the physical conformation of the area and the unevenness of the present equipment of transportation facilities of a piece of land; secondly a city center is a

point where is reached most easily from all other area and the essential quality of a city center is the physical proximity to all part of the area; and lastly, the city is assumed to be isolated. In such an environment, Haig (1926) suggests all the activities will prefer to be located at the city center for the reason of convenience in commuting to all other part of the city. Because of the cost of transportation, the degree of convenience can be generated a saving in transportation cost which is capitalized into land rent. Haig (1926), therefore, suggests a complementary relationship between the transportation cost and the land rent. The highest land rent can be found in the city center which is regarded as the most easily accessible location.

Rent of the land can be regarded as the charge introduced to use a relatively accessible site which gives a lower transportation cost. Haig (1926) describes the site rentals and the transportation cost as the "cost of friction". And he points out that general improvement of the transportation network can reduce the "friction of a space". This makes people easier and cheaper to go to and fro in all part of the state and, thus, reduce the accessibility advantage on transportation in the city center. Consequently, the rent as well as the value of the lands in the city center decrease.

Haig (1926) further raises a suggestion that "*An economic activity will consider the accessibility of a site. Economic activities will automatically take a balanced combination on site rent; time value and transportation cost. This is purely driven by the sensitivity of the economic activities on the extent of accessibility required*." For instance, there is an economic activity which is very sensitivity on its accessibility; it would eventually choose to locate in the city center rather than the other remote area in the city. On the contrary, a low accessibility-sensitive economic activity will not

choose a location in the city center.

Succeeding to what Haig (1926) published which is about an image of the relationship between the land value and its location. Alonso (1960) develops his model on the relationship between location and rent in mid-twentieth century. This model, named as bid-rent model, is based on several assumptions: a central business district (CBD hereafter) with all job locations and surrounded by a ring which contains all residences situated in a featureless plain; all households are assumed to have identical utility functions and identical income to spend on housing rentals commuting cost and consumption goods.

Alonso (1960) uses a non-mathematical analysis to constitute his theory of urban land market by starting the analysis in an agricultural model. Given a fixed selling price and costs of production, the only variable directly tied to a farmer's profit is the transportation cost. Alonso (1960) uses an example of wheat to illustrate such situation. The selling price and the production cost of wheat of one acre are $100 and $50 respectively. The transportation cost for the wheat is $5 per mile. In figure 8, straight line RS shows a negatively sloped bid-rent curve for the wheat.

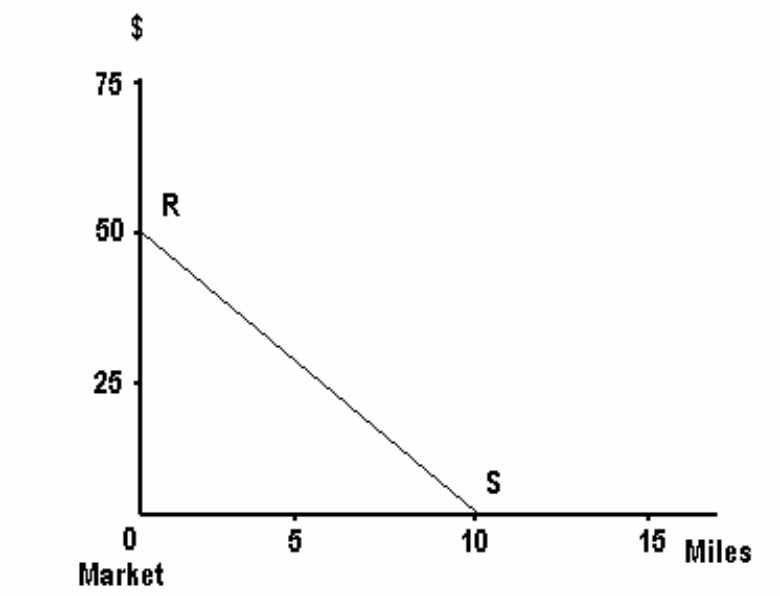

Figure 8: the bid rent curve of wheat cultivation

Source: Alonso 1960, pg. 276

Alonso (1960) explains *"As farmers bid against each other for the more profitable locations, until farmers' profits are everywhere the same, what we have called profits becomes rent. Thus, the curve derived as a farmers' profit curve. Once we distinguish between the roles of the farmer and the landowner, becomes a bid rent function, representing the price or rent per acre that farmer will be willing to pay for land at the different locations."* Simply speaking, a bid-rent curve gives an indication to others that the price or rent of a piece of land is willing to be paid for a specific type of use.

Alonso (1960) shows that different land uses will have different bid-rent curve. He put forward an example that the market price and production cost of one acre of peas are $150 and $75. They are subjected to $10 transportation cost per mile.

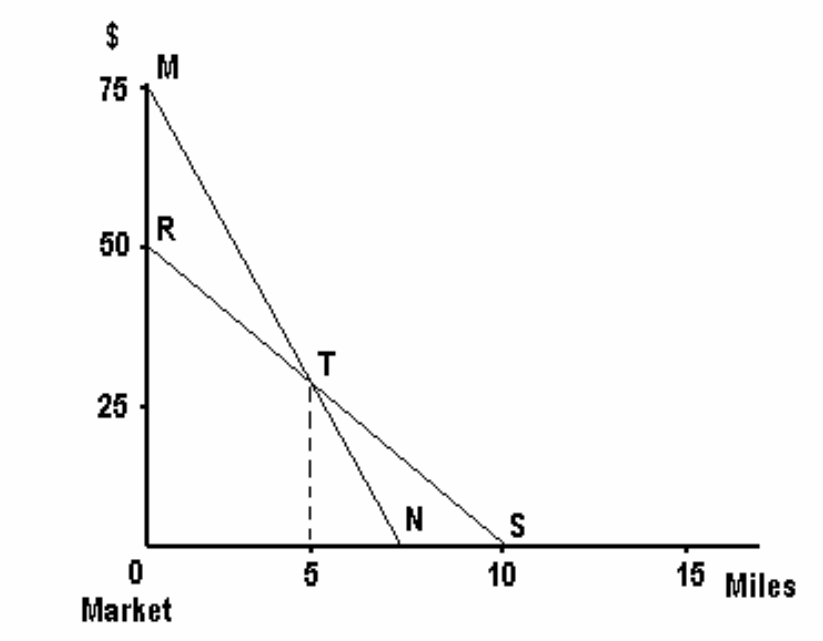

Figure 9: bid rent curve of cultivating peas and wheat

Source: Alonso 1960, pg. 277

Graphically speaking, in figure 9, the straight line MTN is representing the bid-rent curve of cultivating peas and straight line RTS is the one representing the bid-rent curve of cultivating wheat. As a bid-rent curve is the price or the rent the one is willing to pay for, peas' farmers will bid-rent the land in the region within 5 miles to the market at a higher price to the wheat' farmers. So, cultivating peas will prevail in the region within 5 miles to the market. Cultivating wheat will locate in the region where bid-rent curve is higher then the others i.e. region between 5 miles to 10 miles from the market.

Abstracting the views coming from the example of agricultural land use above, it shows that land use, through farmers' competitive bidding, decides land value and the steeper the bid-rent curve, the closer a particular land use will be located from the market or city center.

After stating the use of a bid-rent curve, Alonso (1960) uses the rationale of bid-rent curve to explain land use in residential sector. The bid-rent curve shows the rent an individual is willing to pay at various distance with constant level of satisfaction. Alonso (1960) suggests that *"A consumer, given his income and his pattern of tastes, will seek a balance the costs and bother of commuting against the advantages of cheaper land with increasing distance from the center of the city and the satisfaction of more space for living."* That is, as a matter that the total expenditure of consumption goods is assumed to be the same, the sum of money spending on transportation cost and rent is a constant. Following the logic that transportation cost increase when distance between the site and CBD increase, continue decrease in rent starting from CBD to periphery occurs in order to maintain constant level of satisfaction. Therefore one will consider the location for residential by weighting against the importance of the distance from the city center and its associated advantages.

Remarks concluded from the above literatures that inverse and supplementary relationship is held between a land value and the transportation cost from or to CBD. Unless the accessibility of the land to CBD changed i.e. the transportation cost changed or the transportation time changed, the value of a land will not be different.

3.2 Effect of railway on property price

In the early twentieth century, Hurd (1924) suggests there is a relationship between railway and the land value. *"...street railroads have wrought a revolution in the structure of cities, scattering population over a wide area, adding value to the*

circumstance by rendering it accessible for residences, and to the center by concentration traffic within it…" Hurd (1924) believes railway can add value on a piece of land provided that it becomes more accessible for residences. Although the complexity of a city transportation system now is far more complex than that observed by Hurd (1924), the theoretical point of view from his research has been treated as a major reference to the later research.

Forrest et al. (1996) suggests the effect of railway on residential property price depends on the efficiency of a railway on providing service to passengers. They study the situation in Great Manchester. The railway gives a low rail usage since the mean distance to a station in their data is 1.36km, approximate to 20 minutes walk. Negative correlation between the distance to a railway station and the properties value is found. People may switch to other modes of transport for better service. This suggestion is coherent on the issue that a unit gains no benefit on MTR unless the accessibility of a piece of land or to a unit is improved.

There is a quoting inside the paper written by Forrest et al. (1996). This is the findings from Bajic (1983). Bajic in Forrest et al. (1996) gives an implication to the relationship between the layout of the subway route and the impact to the residential property price by the subway station. He conducts the study from the new Spandina subway in Toronto. An impressive result shows that when the route of the subway, or railway in general, can in bring people to CBD more effectively comparing with other public means to do so, the subway will bring a positive effect on the property price. Bajic in Forest et al. (1996) explains it is as a consequence of direct saving in commuting costs has been capitalized into housing value. Direct saving, therefore, becomes a major component in making the adjustment of property price.

Benjamin and G. Stacy Sirmans (1994) try to measure the effect of proximity of the railway station on apartment rent by using 250 data observation from Washington, D. C. area. They target the rent of the multifamily residential properties, which is similar to the residential building in Hong Kong, near to the Washington D. C. Metrorail station for their study. They find statistically that an adverse effect on the distance from a railway station and the apartment rent. That is *"each one-tenth mile increase in distance from the station results in a decrease in rent per apartment unit of about 2.5%."* It can simply say that there is an inverse proportion relationship between the rent of apartment unit and the distance from a rail station.

On the same field in measuring the effect of proximity of the railway station on property value, Poon (1978) uses the data collected in London, Canada to do the research on this subject. He stands at a point that railway generates pollutions to many people living near the railway tracks. These pollutions or the externalities include air pollution; noise pollution and "visual" pollution. Added from the above, he also believes adverse effects on human health will be appeared as living near the railway track. More than that, he suggests *"unclean air vibration caused by trains may cause damage to structures and results in more frequent repairs and paintings."* He measures the economic cost of railway pollution indirectly by observing the degree of change in the residential property price. And, the result shows negative impact to the residential property price where those properties mainly are next to the railway track or station. The explanations for such impact quoted by Poon (1978) above can not be refuted as a consequence. Compatible to Poon (1978) 's point of view, Forrest et al. (1996) find that too much closer to the station tends to lower property price. This is mainly due to the externalities effect of the station to the

nearby unit. Forrest et al. (1996) suggest the adverse effect on the residential property price is by the reason of noise; high level of vandalism and assaults in the station.

On the other hand, Chau and Ng (1998) reaffirm the positive influence on the residential property price when a location's accessibility has improved. They show the improvement in public transportation has a negative effect on the price gradient along the railway line. More importantly, one of the associated findings from this study is that it takes time for the relative price levels to reach a steady state due to the expectation and adaptation of people to the changes. They say "*owing to people's expectation, it is possible that part of the effects of the improvement would have been reflected on property process before the actual modernization of KCR (the subject railway) was completed. On the other hand, the full effect may not have been fully reflected until the modernization was in place for some time.*" They recorded an increase in the explanatory power[5] after the omission of 1980-1985 data where the first stage of transportation improvement takes place in 1982.

The announcement of the introduction of a new mode of transport also affects the residential price. Gatzlaff and Smith (1993) discover a negative effect on overall prices of residential properties on average in their study of the Miami Metrorail construction. It is largely due to expectation of congestion and increased crime rate. Similar result is given by Henneberry (1998) that negative effect on the property price is shown when the announcement of the introduction of a new mode of transport comes up. Henneberry (1998) explains the result may be a consequence of expectations of disruption during the building of the system. However, McDonald

[5] The explanatory power of a empirical result is reflected by the adjusted R^2 in running a regression model

and Osuji (1995) give an opposite findings from what Gatzlaff and Smith (1993) and Henneberry (1998) have discovered. McDonald and Osuji (1995) find that after the future Midway Line scheme of construction was announced in Chicago, the price of the residential properties, which is within one-half mile of the station, increase.

From the above review, when a railway development is existed nearby, property price is not necessary to be increased. The effect of a railway development on residential property price depends on the accessibility gain in a location to CBD. Besides the accessibility gain, there are number of factors identified by the studies above. An announcement of a railway development does affect residential property price. But, it varies from place to place. It would be better to find empirically rather than theoretically. What is more, it should be noted that draw backs to the nearby residential property are found when a railway is introduced. They are different kinds of pollutions and the externality effect.

3.3 Hedonic Pricing Model

Hedonic pricing model is one of the regression models employed as a research tool for studying the relationship between dependent variable and independent variables in property market. It is based on the assumption that the unknown variable (variable to be forecasted or the dependent variable) can be expressed as a function of some known and measurable variables. In hedonic pricing model, more than one factor can be explicitly taken into account. This method has been extensively applied since it was first proposed by Rosen (1974) as it is seemingly that many factors affect the property price. At the same time, hedonic pricing model can obtain estimates of the value of each factor or constituent which the factors are assumed to be mutually

exclusive. Therefore, people start to use this model to measure the magnitude of each factor contributes to the property price. Point should be noted on identifying the factors which affecting the property price. They should be measurable like the size; the age; the floor; the management body etc.. By doing a regression, an equation is generated. The implicit value of each significant factor is represented by the its corresponding coefficient. By using the hedonic pricing model Freeman (1993) say, *"we can thus have a clear idea of the degree of impact the attributes have on the price of the property"*.

The simplest and most common method of estimating the parameters of the regression model is the Ordinary Least Squares (OLS) technique. It estimates the true but unobservable function by a regression equation:

$y_t = ß_0 + ß_1 x_{t1} + ß_2 x_{t2} + \ldots + ß_K x_{tK} + e_t$

where y_t is the dependent variable; x_K are the independent variables; e_t is the residual and $ß_K$ are the OLS estimators (true unobservable coefficient of x_K). The principle asserts that to fit a line to the data value so that the sum of the square of the vertical distances (the residual) from each point to the line is as small as possible (Hill; Griffths and Judge, 2001).

Assumptions are laid under Ordinary Least Square model. Firstly, assume the dependent variable y is related to the independent variable x in a linear parametric form. Secondly, there is a random sample of size n following the population model suggested. Thirdly, the sample variation is in the explanatory variable. It suggests the sample outcomes on x are not all the same value. Fourthly, the error has an expected value of zero given any value of the explanatory variable. This is usually called coupled with the random sampling assumption. The average effect of the left out

factors, as a result, is zero or constant. Lastly, the model assumes the error has the same variance given any value of the explanatory variable. Mathematically point of view, it represents Variance $_{error} = \sigma^2$. Such an assumption points to an expectation that all the factors generating the error term do not change over the set of observations. And this is also called Homoskedasticity. (Wooldridge, 2006)

The assumptions simplified the model but make it sometimes unrealistic. In assuming the errors in the linear regression model, such as Ordinary Least Square model, were uncorrelated random variable, this may lead to a biased result in the error of estimating the model. This phenomenon comes up easily in a set of data including time-series data where the observations follow a natural ordering through time. This is because there is always a possibility that successive errors will be correlated with each other. And it is autocorrelation. The consequences of autocorrelation are that the least squares estimator for the model is still a linear unbiased estimator, but no longer the best. And, the formulas for the standard errors usually computed for the least squares estimator are no longer correct, and hence, confidence intervals and hypothesis tests that use these standard errors may be misleading. That is, the estimator ($ß_i$) will be biased downward under autocorrelation, so calculated t-value is larger than the actual t-value and therefore the coefficients that are in fact insignificant may be shown to be significant using the standard t-test. (Hill; Griffths and Judge, 2001).

On other hand, another assumptions for the linear regression model is constant variance (σ^2) among all observation --- homoskedasticity. This assumption may not be valid when the date comes across either cross-sectional data or time-series data. Chances for different variances, or heteroskedasticity, may emerge. "*The term*

cross-sectional data refers to having data on a number of economic units such as firms or households, at a given point in time. And, time-series data refers to having data over time on one economic unit" (Hill; Griffths and Judge, 2001). Heteroskedasticity may also be occurred when there is/ are missing variable/ variables or mis-specification of the functional form. If using a linear regression model with the problem of heteroskedasticity to estimate the unknown coefficients, then the estimator of the model no longer the best linear unbiased estimator; the standard errors usually computed for the least squares estimator are incorrect, and, confidence intervals and hypothesis tests that use these standard errors may be misleading. (Hill; Griffths and Judge, 2001).

There are still problems existed in the regression model. When there is a high correlation relationship between two or more independent variables, this is called multicollinearity. This would be the consequence of small sample size or two or more independent variables are correlated. The problem of multicollinearity may lead to an overestimated coefficient/ estimator ($ß_i$). And therefore, t-test is not applicable in such a case. (Wooldridge, 2006)

Data problem affects fundamentally the accuracy on doing a regression. It is easily found that data is missing when collecting a random sample of data. If data are missing for an observation on either the dependent variable or one of the independent variables, then the observation cannot be used in a standard regression analysis. It makes the size of the random sample available from the population is simply reduced which results in less precise findings. Another data problem is collecting a non-random sample from the population. Non-random samples from an underlying population can lead to biases in Ordinary Least Square regression model.

When sample selection is correlated with the error term, the model is generally biased and inconsistent. (Wooldridge, 2006)

Apart from the limitation and problems associating with doing regression, choosing the right functional form for doing a regression is also of great moment. There are numbers of function form to achieve the regression. It can be linear model; reciprocal model; log-log model; exponential model; semi-log model; log-inverse model etc.. Issue should be considered that whether a selected function is best describe the observation. "*As rent is a result of, and not the cause of, demand*" (Jao, 1976), the demand and supply of the residential properties determine its price. Freeman (1993) says "*market price of a property is generally a function of location, structural and neighborhood attributes. And, this function does not necessarily be linear"*. He explains that different market will have different functional form which reflects the hedonic price structure. Other form of function such as semi-log and log-linear could also be the most suitable functional form to represent the regressed equation. This is determined by the Box-Cox (1964) transformation. Mok et al. (1996) suggest the functional form of the market price of a property is P= f (L, S, N) where L, S, N are the locational, structural and neighborhood attributes respectively. Craig et al. (1998) concludes "*the functional form for the hedonic equation is not determined theoretically… Rather, it is determined empirically.*" Therefore, different functional form will be tried to achieve the best fit to the collected data. A priori knowledge on the observation can help in deducing the function form of the model.

3.4 Property price attributes

Alonso's bid rent model is built under a highly simplified situation which includes

only the factor of accessibility of a site. However, Not only the accessibility of a site contribute to the price of a land, but also the factors such as the structural attributes; site attributes and even the income of residents (Linneman, 1982). Lusht (1997) finds other factors which also affect the property price. They are geographic attribute; government regulation; social and cultural impacts. A more systematic way to classify the property price attributes can be found from Mok et al. (1996). He suggests that property price attributes can generally be divided into three categories. They are namely locational; structural and neighborhood attributes. Using this as a basis, the determinants of the residential property price from the past studies will be tried to allocate into these three categories.

3.4.1 Locational attributes

Locational attributes can be one of the components of the geographic elements of a residential property. It determines the environment which the residential property to be facing. What is more, the location of a site decided the distance to CBD. Such distance is vital to the value of residential property price and it has been addressed in a number of researchers such as Hurd (1924); Haig (1926); Alonso (1960) etc.. Lusht (1997) proved that such an attribute affect the property price. And, as reviewed from a number of literatures, the distance between an apartment and the railway station is an attribute to the property price.

3.4.2 Structural attributes

Size, one of the major structural attributes to a residential property price, is

found no doubt on positively affect the residential price. The larger the saleable floor area or the useable floor area, the higher the property price. However, it becomes controversial when considering the price per unit floor area. Mok et al. (1996) demonstrate the larger the size of the property, the lower will be the unit price in their study in Hong Kong. On the contrary, Huh and Kwak (1997) conduct a similar study in Seoul of Korea which tests whether the rate of each additional unit of floor area will decrease or not if the floor area increase. The result goes against what Mok et al. (1996) has found.

Another major structural attributes to a residential property price is the floor level of a property. Mok et al. (1996) suggests the higher the floor level of a property, the higher its price. This is solely by the reason of better outdoor environmental view that a property located at a higher level can provide. The explanation is further assured by Ho (1999) who studies the impact of view on the property price. He finds that a sea view; a river and a racecourse are of positive effect on the property price particularly in Hong Kong real estate. A reclamation project, however, located next to a property will negatively affect the property price.

Age, following with major factors of the size and the floor level of a property, is found to be negatively affecting the property price when the age of a property goes up. It is proved by Bible et al. (2002) who examine the sales price of residential properties.

3.4.3 Neighborhood attributes

Neighborhood attributes, as it was named, are the attributes coming from the neighborhood of the factors outside the subject building. Huh and Kwak (1997) conclude in their empirical study that famous schools have its positive impact on the nearby residential properties. Nevertheless, Huh and Kwak (1997) show when hospital or green belt is next to a residential property, it makes a negative effect on the property price. Huh and Kwak (1997) explain that development potential will be hindered in an area zoned as green belt. This potential change affects the resale value of a residential property. For the factor of hospital, because of substantial traffic and disturbance generation, negative impact is expected.

3.4.4 Other attributes

Other then the factors suggested in the above categories, Lusht (1997) suggests, in a macro point of view, the factors including government regulations; social and cultural impacts are significant to a property price.

On the other hand, Chau et al. (2001) find "lucky floor" number are considered to "*command a premium in property price during a market boom. But the premium reduces when there is a market downtur*n". This is explained by Chau et al. (2001) that the "lucky floor" numbers i.e. 8^{th} floor, 18^{th} floor, 28^{th} floor etc. are pronounced as if it means "prosperous" and "wealthy" in Cantonese.

Another study conducted by Chau, Ng and Hung (2001) shows that purchasers is willing to pay at least 7% premium on the price of an apartment which is solely due to a Hong Kong developer's goodwill. In other words, reputation of a developer affects a property price.

In conclusion, distance to the CBD is one of the factors affecting the residential property price if the data sample adopted is not relatively close together. The factors such as the distance to the nearest railway station; size; age; floor level of the residential unit are at important in calculating the value of a residential property. Other than the above major factors, factors such as the nearby environment; lucky floor and developer's goodwill are found to be significant on the residential property price in different literatures.

Chapter 4: Methodology and data collection

In my study, I set one's attention on the inference of a railway station with non-direct railway alignment to the CBD on residential property prices in Hong Kong. The target subject of my study is the West rail which gives a significant detour in railway alignment in traveling to the CBD. Property transactions around Tuen Mun West rail station will be focused on and that around Yuen Long West rail station will also be studied to serve as a control experiment to the Tuen Mun study. As there are plenty of residential property transaction data in primary and secondary residential property markets, hedonic price model will be employed in my study.

In the following, the study target and the hypothesis made in the study will be presented sequentially. Then, the model and the functional form in my study will follow. Finally, I will go through the expected results of the equation for the regression analysis.

4.1 Target of the study

West rail of the Kowloon-Canton Railway Corporation (KCRC) is the target of my study. I chose Tuen Mun terminus as the focal point of my study not only because of sufficient amount of residential property transactions nearby the station but also the station suffering the greatest detour in terms of railway alignment traveling to the CBD direction.

Yuen Long station has been chosen as a control experiment to the study area. The reason why Yuen Long station has been chosen is that it is situated in Yuen Long

district which has similar district characteristics to Tuen Mun district. They are full of people in working age and they are located adjacent to each other and give similar direct distance to the CBD in Hong Kong.

4.2 Hypothesis

In Hong Kong, the major competitor to the railway companies is from the vehicular public transportation. In figure10, it shows the share of different transportation companies in Hong Kong. The franchised bus services and the railway service provided by MTR and KCRC dominate the public transportation sector in Hong Kong.

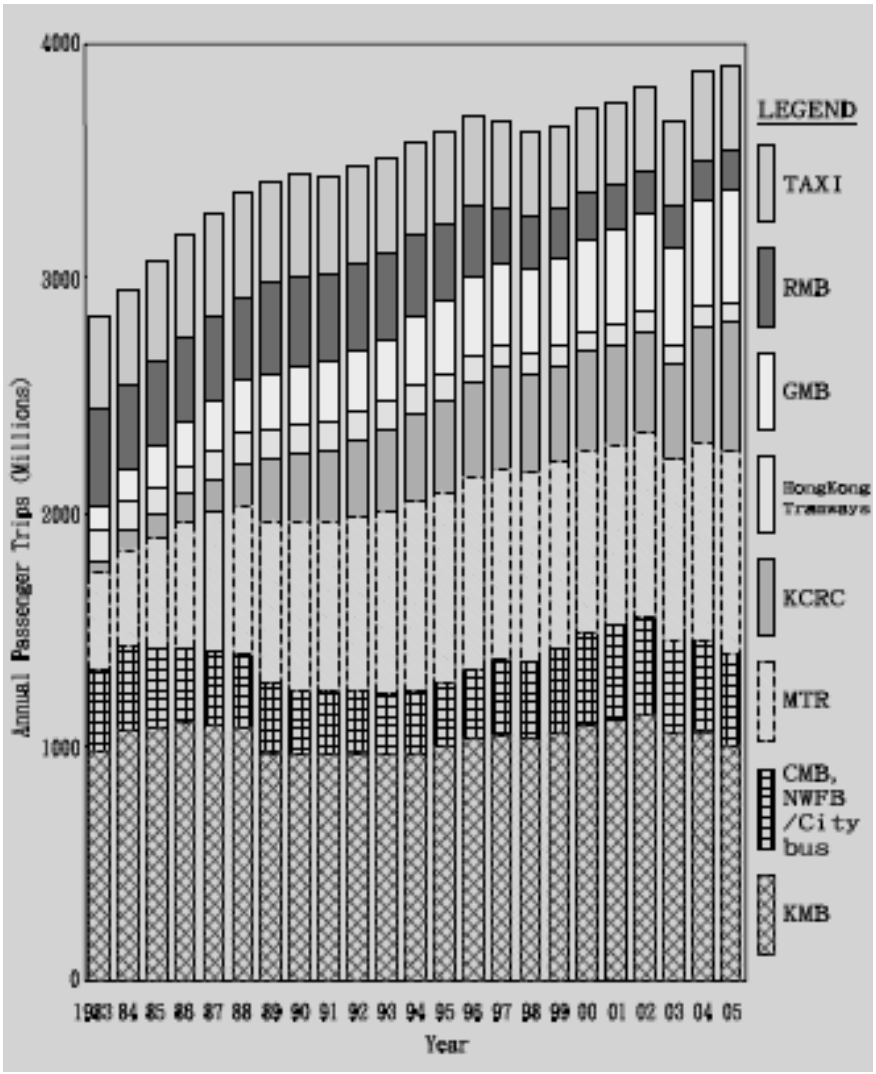

Figure10: Distribution of annual passenger journeys among taxi, RMB, GMB, Hong Kong Tramways, KCRC, MTR, CMB, NWFB/Citybus and KMB (1983-2005)

Source: Transport Department

In chapter 2, it is mentioned that a site value is relating to its accessibility. The gain in accessibility will contribute to the residential property price. While the externalities generated by the railway or railway station will give a negative impact on the price of nearby residential properties. The sum of those will be capitalized on the residential property value.

It can be seen on the figure 6 that the Tuen Mun West rail terminus will have to take a big detour to go to CBD direction by passing through Tin Shui Wai and Yuen Long district. A faster path by riding a bus or minibus from Tuen Mun Road to CBD exists in reality. Therefore it is doubted whether there is accessibility gain to the area around Tuen Mun West rail station to go to CBD when West rail has been introduced to Tuen Mun. To the area around Tuen Mun West rail station, externalities come from the railway or the railway station will still exert its inference to the nearby residential properties. So, one would expect Tuen Mun West rail terminus will bring negative effect to the nearby residential properties.

Therefore, we come with the first hypothesis in the study:
"The presence of a railway station with a non-direct railway alignment to the CBD has a negative effect on the price of adjacent residential properties."

In order to test this hypothesis, transactions of the residential properties nearby the Tuen Mun West rail station will go through a regression model. The coefficient of the dummy variable on the operation stage of West rail can tell whether this hypothesis should be rejected or not.

On the contrary, in Yuen Long West rail station, there is no big different between the railway path and the road path to go the CBD. In other words, there is no detour in railway alignment from Yuen Long West rail station to the CBD. Railway has been seen as a faster mean to go to a destination comparing to road transportations. It is due to the saving of congestion time in the vehicular transportation network. As observed, people in Hong Kong are generally time conscious. "Time is money" is a common slang among Hong Kong community. Therefore, with a direct route

alignment to CBD which gain accessibility of a site, it is believed a positive impact will be brought by a railway station, on nearby residential property prices although the externalities of a railway station still exist.

Now, we have the associated hypothesis in the study:
"The presence of a railway station with a direct railway alignment to the CBD has a positive impact on the price of adjacent residential properties."

Transactions of the residential properties nearby Yuen Long West rail station will be tested for the relationship between the railway station and the price of its nearby properties. A separate model of regression will test this hypothesis. A dummy variable will tell the different in terms of property price between the time with and without the operation of West rail.

The second hypothesis is to prove the significance of KCRC West rail to nearby residential property prices. With the proof, it can affirm the first hypothesis that the impact on the residential property prices nearby is due to the non-direct railway alignment of West rail.

4.3 Model for empirical test

Hedonic price model is commonly used in doing empirical studies. It has long been proved with its usefulness as an analytical device. Hill; Griffths and Judge (2001) say "*Hedonic modeling can deal with cross-influences between numerical factors affecting on property prices so as to achieve the most favorable model design with minimized the least of information*". The purpose of using hedonic modeling is to

assess the particular contribution of each attribute of the residential bundle on market value by using regression method. This study will adopt hedonic price model for running the regression.

Under the hedonic price model, ordinary least square (OLS) technique will be used. This is a principle which asserts to fit a line to the data values (Hill; Griffths and Judge, 2001). We should fit the line so that he sum of the squares of the vertical distances from each point to the regression line is as small as possible. The vertical distances are squared to prevent the cancellation of each other with the positive distance and negative distance. Hill; Griffths and Judge (2001) say "*this rule is arbitrary but very effective, and is simply one way to describe a line that passes through the middle of the data*." A line of best fit to the data will be generated and there are a number of statistics to determine the validity of the regression line.

4.4 Interpretation of statistics

The empirical study is backed up by statistic. A number of useful statistic test results from running a regression give evidence to support an empirical study. They will be discussed in the following.

4.4.1 Coefficient of determination (R^2)

The coefficient of determination (R^2) is a descriptive measure. It is defined in the range from 0 to 1. The closer R^2 is to 1, the higher the explanatory power in explaining the variation in the dependent variable by the constructed model. Also, the closer R^2 is to 1, the greater is the predictive ability of the

constructed model over all the sample observations (Hill; Griffths and Judge, 2001).

For instance, if R^2 =1, all the sample data fall exactly on the fitted least square line. In other words, all the sample data can perfectly be explained by the constructed model and the model fits the data. On the contrary, if the sample data are uncorrelated show little association with the least square line, then the R^2 will tend to 0.

4.4.2 t- statistic and significance level

t- Statistic and significance level of a coefficient is closely related together. The t- statistic is used to test the significance of the coefficient. It is simple to compute given coefficient of an attribute and its standard error (Wooldridge, 2006). Point should be noted that the value of t –statistic gives no importance to the magnitude of the coefficient of an attribute.

t- Statistic can be calculated through econometric software by computer given the formula of $t = ß_i / se(ß_i)$

where $ß_i$ is the regression coefficient of the attribute x_i

$se(ß_i)$ is the standard error of $ß_i$

It takes its effect to show the significance of the regression coefficient of the attribute when the critical value in a regression model has been set. For 95% level of significance/ confidence, the critical value for standard normal distribution curve is 1.96. It means if the magnitude of a t- statistic is higher

than 1.96, the coefficient of the attribute is significant at 95% significance level/ confident level.

4.4.3 F- statistic

F- Statistic can be used to test the significance of the coefficient of determination (R^2). The higher is the magnitude of F- statistic, the more significant the coefficient of determination. And thus the independent variables give significant explanatory power in explaining the variation of the dependent variable.

4.5 Data collection

Two West rail station are chosen as the target for sample data collection. The first one is the Tuen Mun West rail station and the second one is the Yuen Long West rail station. Tuen Mun West rail station area, as it is the target location for this study which gives a non-direct railway alignment, is surrounded by a number of residential blocks or estate. Data sample is easy to be collected. On other hand, Yuen Long West rail station is chosen for the study not only the station gives no detour in the railway alignment to the CBD, but also it is surrounded by lots of residential properties.

The transactions in Hong Kong primary and secondary property markets are very active. A large amount of transactions eliminate the effect of random error in the sample of data.

Data sample from these two areas are collected from the data recorded by Economic

Property Research Centre (EPRC). EPCR data contains the property transactions registered in the Land Registry in Hong Kong. It has been recorded and updated since 1991 and it is one of the most popular data used by different industries like banking, developers, real estate agency firm etc.. Information such as the consideration of a transaction of an unit; date of transaction; gross floor area of an unit and any other remarks indicating other important issue can be found in the EPRC databank.

The transaction data recorded in EPRC data are the conclusion of property transaction. A property transaction may represent a transaction of an apartment and together with a car parking space or with the roof. As this study is not aiming at studying the effect of car parking space or a roof tied together with the sale of an apartment unit, this kind of data will be excluded for the reason of controlling the effects of this kind of factor. Technically speaking, for the sample date marked with "roof"; "RF"; "F/R"; "FR"; "Penthouse"; "Duplex"; CPS"; "INCL"; "portion" and "share of unit" in either column REM1 or REM2, they will be excluded for running the regression.

Data sample from EPRC databank for residential property transactions are collected from 1st January, 1995 to 31st December, 2006. This period covered both the announcement period; construction period and operation period of West rail. This makes the study possible to assess the inference to the residential property prices in different period.

The sample size for doing regression in Tuen Mun area is 3886 transaction records, which is selected from four housing estates (Tuen Mun Town Plaza, Kam Wah

Garden, Hong Lai Garden and Tai Hing Garden). These housing estates are one of the most nearest housing estate to the Tuen Mun West rail station. Whilst, the sample size for doing regression on the Yuen Long area is 4,144 transaction records which is selected from three housing estate (Sun Yuen Long Center; Yoho Town and Shun Fung Building). They are one of the most nearest housing estate or single building to the Yuen Long West rail station. The map which illustrates where do these housing estates locate can be found in Appendix I.

4.6 Functional form

Choosing a function form depends on the nature of the relationship between the dependent variable and the respective independent variables. A correct form of function is highly relating to the accuracy of the estimation. But, there is no functional form true for universal for a dependent variable. For example, a functional form studying the residential property price may varies from the one in mainland China to that in Hong Kong. A prior knowledge of the relationship between the dependent variable and independent variables or even the function helps in deducing the right functional form in the study.

The functional form for the study will be selected based on trial and error basis. The one with the highest explanatory power (Adjusted R^2) will be adopted in this dissertation.

There are a lot of functional forms possible for describing the residential property price behavior. Other than the ordinary linear form is possible, polynomial form; semi-logarithmic form and logarithmic form are also possible. They all will be tested

respectively in order to pick up the one with the highest explanatory power. Because the linear form is the easiest functional form in doing regression, it is usually used to test the regression before the other more complicated functional form undergoes the testing processes.

The linear functional form assumes the dependent variable is in linear relationship to the corresponding independent variables. The following is the mathematical expression of the hedonic equation:

$y_t = ß_0 + ß_1x_1 + ß_2x_2 + \ldots + ß_kx_k + e_t$

or equivalent to

$$y_t = ß_0 + \sum_{i=1}^{k} ß_i x_i + e_t$$

Where y_t = the dependent variable

$ß_0$ = constant term

$ß_i$ = regression coefficient of the attribute x_i

e_t = error term

The regression coefficient of the attribute x_i represents the rate of change of dependent variable with respect to the corresponding attribute x_i. It is because, by the partial derivative with respect to the i^{th} attribute, we have:

$\partial y_t / \partial x_i = ß_i$

In a linear functional form of regression, the rate of change of dependent variable is in straight line basis.

Other functional form may have different implication between the coefficients and the dependent variable. Taking a polynomial functional form as an example:

$y_t = ß_0 + \alpha_1 x_1 + ß_1 x_1^2 + \alpha_2 x_2 + ß_2 x_2^2 + \ldots + \alpha_i x_i + ß_i x_i^2 + e_t$

or equivalent to:

$$y_t = ß_0 + \sum_{i=1}^{k} \left(\alpha_i x_i + ß_i x_i^2 \right) + e_t$$

The rate of change of dependent variable with respect to the corresponding attribute x_i is not necessarily a constant. The partial derivative with respect to the i^{th} attribute is:

$\partial y_t / \partial x_i = \alpha_i + 2ß_i x_i$

The rate of change of the i^{th} attribute in polynomial functional form is different from that in linear functional form. The effects are summarized in table 3:

The sign of coefficient of the i^{th} attribute (α_i)	The sign of coefficient of the square of i^{th} attribute ($ß_i$)	Implication to the dependent variable by the i^{th} attribute (x_i) (taking other attributes as constant)
+	+	Dependent variable increase exponentially as the i^{th} attribute increase
+	-	Dependent variable increase with a decreasing rate of increase as the i^{th} attribute increase
-	+	Dependent variable decrease with a decreasing rate of decrease as the i^{th} attribute increase
-	-	Dependent variable decrease exponentially as the i^{th} attribute increase

Table 3: Implication by the coefficient of the i^{th} attribute to the dependent variable

In this dissertation, cross function between linear and polynomial functional form

will be used as it gives the highest explanatory power to the set of data.

4.7 The Variables

There are vast amount of variables affecting the residential property prices. However, it can be generally divided into three main categories according to Mok et al. (1996). He suggests that property price attributes can generally be divided into three categories. They are namely locational; structural and neighborhood attributes. This study will stick onto this classification. Mathematically, it equals to:

$P = f(L, S, N)$

Where P = Residential property price

L = Locational attributes

S = Structural attributes

N = Neighborhood attributes

To maintain the simplicity of the regression model, only the independent variables which are critical in relation to the dependent variable will be selected in this study. The critical independent variables to the residential property prices are drawn from the previous studies. Table 4 shows the chosen independent variables for the study sorted by categories:

Category	Variable
Structural attributes	AGE – Age of the building with respect to the transaction date BLOCKS – Number of blocks in the Estate FLOOR – Floor level SIZE – Gross Floor Area
Locational attributes	DIST- Direct distance from the nearest West rail station
Time dummy	AS- Announcement stage CS- Construction stage OS- Operation stage

Table 4: the chosen independent variables for the study sorted by categories

It is found from the previous study that sea view cost a premium. However, this cost no different in the study as there is no sea view in the chosen area. Lastly, for the neighborhood attribute, since they are facing with similar neighborhood factors such as the monthly income per household and the culture, no neighborhood factors are employed.

To cope with the problem of heteroskedasticity in the regression model, White's standard errors were used to do the adjustment.

4.7.1 Dependent variable

i. RPRICE (Real price of property per square foot in 1999)

The dependent variable (RPRICE) is the deflated selling price of the apartment in HK dollar per square foot of the saleable area.

The nominal price indicated in the EPRC shows the dealing price at a particular date. Because of the fluctuation of the real estate market due to the problem of inflation, this nominal price will generate a time series problem. To eliminate such problem, the nominal price in the data sample will be deflated by the price index published in the Hong Kong Property Review by the Rating and Valuation Department (RVD). The price index is designed to measure rental and selling price changes with quality kept at a constant. A base year for comparison will be selected by the Rating and Valuation Department. The latest publishing indices are compared based on year 1999. That means all the transaction will be deflated into the price level in 1999 for comparison.

The price index for residential properties in Hong Kong is measured by class in yearly, quarterly and monthly basis. To deal with the problem of accuracy, a more detail measurement will be adopted. Therefore, monthly residential property price index by class will be used to deflate the nominal price. The price indices from 1995 to 2006 can be found in Appendix II.

The real price of the properties at 1999 level is calculated by:

$$RPRICE = N*100/ I$$

Where RPRICE = Real price of property per square foot in 1999

N = Nominal price of the property

I = Monthly price indices to the corresponding transaction date

The raw source of data about the nominal transaction price can be adopted from the EPRC data.

4.7.2 Continuous independent variables

i. AGE (the age of a residential property in month)

AGE refers to the age of a residential property when the transaction was made. It can relatively measure its condition of status. It can act as an implicit indicator to the condition of a property except when renovation takes place. Real estate property can be treated as a deteriorative object standing on a piece of land. It is a normal phenomenon that such an object deteriorates when it's time of existence increase.

The data of AGE are calculated in monthly basis. This figure can be obtained by calculating the different in terms of number of month between the date of issuing occupation permit and the date when the transaction was made. These two critical dates are recorded in the EPRC data.

ii. BLOCKS (Number of blocks in the Estate)

BLOCKS makes reference to the number of building blocks per development/ per estate. It is used as one of the independent variable in the equation for measuring the estate effect. The larger the number of blocks in an estate, the more likely a better facility and amenity level will be provided in an estate.

This is due to the result of economic of scale.

The number of blocks in an estate will not be shown on the EPRC data. This sort of data will then need any way to get access. Fortunately, the number of blocks in an estate can be simply counted from a map. This data will rely on the Centamap which incorporates with Lands Department to provide map service on internet in Hong Kong.

iii. DIST (Direct distance from the nearest West rail station)

The independent variable DIST is to measure the direct distance from the nearest West rail station. It is measured in meter scale. It is used to indicate the change of residential price gradient against the direct distance from the West rail station. The sign and the magnitude of the corresponding coefficient are likely to be affected by the externality effect generated from the station and the accessibility gained by the residents.

This factor can be measured via a Hong Kong map. This data will rely again on the Centamap which provide map service on internet in Hong Kong.

iv. FLOOR (floor level)

FLOOR describes the floor level of a transacted apartment. The floor level of a residential unit relates to the view that the corresponding unit can be provided and also the level of externality effect an apartment will be suffered. Generally, in terms of the matter of apartment view, the higher floor level of

an apartment gives a better outside view. On the other hand, in relating to the matter of externality effect, it is more likely a lower floor level of an apartment unit will suffer more by the nuisance such as noise generating from the economic activities.

The floor level of a residential unit can be obtained directly from the EPRC data. The "lucky floor" such as 8th floor; 18th floor; 28th floor etc. will be discarded in the data sample as Chau et al. (2001) found such floors command a premium. In this way, the data sample can eliminate the lucky floors effect which it is not one of the objectives in this study.

v. Size (saleable floor area of the unit)

Size of a residential property is one of the major attribute to the residential property price. It measures the size of the unit which was put into transaction. It is clear that a larger residential unit is more expensive than that with smaller size (keeping all other factors constant). However, the price per square foot is another matter. Mok et al. (1995) finds in Hong Kong that "*it may be a pricing strategy that the price per square foot for the bigger flats is slightly lower than that of a much smaller flat*." Given a similar culture among the districts in Hong Kong, the relationship between the dependent variable (RPRICE) and the independent variable (SIZE) should be expected a negative sign.

In this study, saleable floor area will be used as a proxy to indicate the size of a residential unit. Saleable area, according to the Code of Measuring Practice published by the Hong Kong Institute of Surveyor (1999), "*comprises the*

floor area exclusively allocated to that unit including balconies and other similar features but excluding common area such as staircases, lift shafts, lobbies and communal toilets". Different from the gross floor area which define as "*the sum of saleable area of the flat together with a proportionate share of all common areas approved by the Building Authority*" (Legislative Council, 1999). Saleable floor area is the area a purchaser pay for in purchasing a residential unit. In other words, saleable floor area is the area exclusively enjoyable by the property owner. This data will appear in each of the transactions in EPRC.

4.7.3 Dummy independent variables

Dummy variables are used to qualitative factors in the model which affect the dependent variable. Either value of 1 or 0 will be allocated on the data. In general, if a qualitative factor can be categorized into n different categories, (n-1) dummy variables are required to model the effects of the factor. The dummy variables in this study are mainly for dividing the time series. The time line is divided into four parts/ categories, thus three time-dummy variables will be used. The four parts/ categories of the time line are the stage where there was no any idea of West rail project by the citizen; the stage where the West rail project was announced; the stage where the construction work of the project was taking place and the stage where the West rail has been start its commission. Three dummy variables are the announcement stage (AS); the construction stage (CS) and the operation stage (OS). The hidden category refers to the stage where there was no idea of West rail project by the citizen. The coefficients of the dummy variables AS; CS and OS should be

interpreted as the implicit price of their respective time period relative to the hidden category. These three dummy variables are discussed in the following.

i. AS (Announcement Stage)

AS refers to the announcement stage in the West rail project. Announcement of a railway project do affect the residential property price. Writers Gatzlaff and Smith (1993); Henneberry (1998) and McDonald and Osuji (1995) have proved the validity of this statement. But the effect varies among cities. The announcement stage is defined as the period between the official announcement of the railway project and the date just before the construction of the project take place. This period is from 3rd October 1997 to 25th October 1998 in the West rail construction project. For any transactions fall within this period in the data sample, the value of AS dummy is 1. Otherwise, the value of AS dummy is 0.

ii. CS (Construction Stage)

Construction stage should be distinguished out from the time line because of the pollutions and nuisances generating to the nearby residential properties. The construction stage is defined as the period when construction activities get started. This period is from 26th October 1998 to 31st October 2003 in the West rail construction project. For any transactions fall within this period in the data sample, the value of CS dummy is 1. And for those who do not appear within this period, the value of CS is 0.

iii. OS (Operation Stage)

Operation stage is the stage where the study is focused on. Operation stage starts when the first train commissioned its duty for business. The period is all the date after 20th December 2003 in the West rail project. For all transactions which were signed after 20th December 2003, they will be regarded as one of the members in OS. They will be given the value of 1 in the OS dummy. Other transactions will be marked as 0 in OS.

4.8 Descriptive statistics

The following is the descriptive statistics for the variables in Tuen Mun data sample and Yuen Long data sample respectively:

Tuen Mun data sample[6]:

	Mean	Std dev	Min	Max
Relative property price per square foot(RPRICE) (HK$ mil)	1.20	0.241	0.007	2.17
Building age (month)	129	45.4	28	241
No. of blocks per development	6.93	3.40	2	11
Direct distance to the nearest West rail station (meter)	473	71.4	310	530
Floor level	18.1	9.21	1	37
Saleable area (size) (sq ft)	436	83.9	181	596
Announcement stage	-	-	0	1
Construction stage	-	-	0	1
Operation stage	-	-	0	1

Table 5: Descriptive statistics for Tuen Mun data sample

[6] The figures inside are corrected to the nearest 3 significant figures

Yuen Long data sample[7]:

	Mean	Std dev	Min	Max
Relative property price per square foot(RPRICE) (HK$ mil)	2.01	0.492	0.091	4.06
Building age (month)	15.3	40.9	-20	169
No. of blocks per development	7.74	2.07	1	9
Direct distance to the nearest West rail station (meter)	376	198	50	500
Floor level	18.4	10.6	1	41
Saleable area (size) (sq ft)	472	106	237	875
Announcement stage	-	-	0	1
Construction stage	-	-	0	1
Operation stage	-	-	0	1

Table 6: Descriptive statistics for Yuen Long data sample

4.9 Equation for the study

With the purpose of showing the presence of a railway station, with a non-direct railway alignment to the CBD, has a negative impact on nearby residential property prices; and The presence of a railway station, with a direct route alignment to the CBD, has a positive impact on nearby residential property prices, two equations are constructed for the data sample in Tuen Mun and Yuen Long area respectively.

Tuen Mun

$$RPRICE = ß_0 + ß_1AGE + ß_2AGE^2 + ß_3BLOCKS + ß_4BLOCKS^2 + ß_5DIST + ß_6DIST^2 + ß_7FLOOR + ß_8FLOOR^2 + ß_9SIZE + ß_{10}SIZE^2 + ß_{11}AS + ß_{12}CS + ß_{13}OS$$

[7] The figure inside are corrected to the nearest 3 significant figures

Yuen Long

$$RPRICE = ß_0 + ß_1AGE + ß_2AGE^2 + ß_3BLOCKS + ß_4DIST + ß_5DIST^2 + ß_6FLOOR + ß_7FLOOR^2 + ß_8SIZE + ß_9SIZE^2 + ß_{10}AS + ß_{11}CS + ß_{12}OS$$

where $ß_0$ is the constant, $ß_i$ (for i= 1,2,…,11) is the regression coefficients.

4.10 Expected result

The subject of the study, the time dummy variable in the operation stage of the West rail, is expected to have a negative impact to the residential property prices in Tuen Mun regression model. This is for the reason that the non-direct railway alignment connecting the Tuen Mun West rail station gives no gain to the accessibility in terms of traveling time in Tuen Mun. Road transportation still serves as the most efficient means in connecting people in Tuen Mun area to the CBD. At the same time, externality coming from the Tuen Mun West rail station may be capitalized to the residential property nearby. So, an inverse relationship between the dummy variable OS and the dependent variable (the relative price) is expected. On the contrary, Yuen Long West rail station gives a totally different situation to that in Tuen Mun West rail station. The railway alignment starting from Yuen Long West rail station to the CBD is relatively direct comparing with the vehicular transportation network. Without any detour, Yuen Long West rail station increases the accessibility to local residents. Therefore, one should expect the dummy variable OS in Yuen Long sample data will have a positive impact to the dependent variable.

The announcement effect which will be shown on the coefficient of the dummy

variable AS can not be predicted at this stage. Previous studies discussed in the literature review can not conclude the effect of announcement of a railway project. The annoumcement effect varies from place to place. So, it would be better to find empirically rather than theoretically.

The magnitude of the coefficient of construction stage dummy variable (CS) will be expected less than the on in announcement stage (AS). Nuisances generated from the construction period will be likely capitalized in the residential property price especially for a long construction project. West rail project construction started from 26th October 1998 to 31st October 2003. For a five years construction period, nuisance effect must exist. However, the extent of the construction nuisance effect exerts on the property can not be predicted at this stage.

The age as well as the size of the property is expected to have an inverse proportion relationship to the dependent variable (relative price per square foot). When the age of a property increase, it is surely the property itself will deteriorate. Management fee will then increase consequently and will be capitalized into the property price. For the size factor, negative effect to the relative price per square foot will be expected due to the pricing strategy (Mok et al., 1995). So both age and size factors will be expected a negative sign in their corresponding coefficient. Another point should be considered, residential properties in Hong Kong can never reach a zero value. So the only possible expectation to these factors affecting the dependent variable is decreasing with a decreasing rate of decrease.

Next, the blocks and the floor level will be expected to have a positive inference to the relative property price per square foot. This is of the reason of estate effect and

better living environment respectively. For these two factors, when they are increased in a certain level, there will not be too much different from the privileges can provide i.e. the facilities and amenity level of an estate with 6 blocks of buildings will not varies a lot to that with 9 blocks; the environment enjoyed by 30^{th} floor will not differ a lot from that in 35^{th} floor. So, a monotonic increasing function will not expected to affect the dependent variable, rather, increasing with a decreasing rate of increase will be expected.

The coefficient of the independent variable DIST is likely the balance between the nuisance effect generated from the West rail station and the accessibility gain due to West rail. As these two components can not be deduced accurately, the prediction of the coefficient of DIST can not be made at this moment.

The expected results of the coefficients of the corresponding attribute are summarized in Table 6 and Table 7 for Tuen Mun data sample and Yuen Long data sample respectively:

Independent variables	Expected sign of the coefficient
AGE	NEGATIVE (-ve)
AGE^2	POSITIVE (+ve)
BLOCKS	POSITIVE (+ve)
$BLOCKS^2$	NEGATIVE (-ve)
DIST	UNKNOWN
$DIST^2$	UNKNOWN
FLOOR	POSITIVE (+ve)
$FLOOR^2$	NEGATIVE (-ve)
SIZE	NEGATIVE (-ve)
$SIZE^2$	POSITIVE (+ve)
AS	UNKNOWN
CS	UNKNOWN
OS	NEGATIVE (-ve)

Table 7: Expected sign of the relative coefficient in Tuen Mun data sample

Independent variables	Expected sign of the coefficient
AGE	NEGATIVE (-ve)
AGE^2	POSITIVE (+ve)
BLOCKS	POSITIVE (+ve)
DIST	UNKNOWN
$DIST^2$	UNKNOWN
FLOOR	POSITIVE (+ve)
$FLOOR^2$	NEGATIVE (-ve)
SIZE	NEGATIVE (-ve)
$SIZE^2$	POSITIVE (+ve)
AS	UNKNOWN
CS	UNKNOWN
OS	POSITIVE (+ve)

Table 8: Expected sign of the relative coefficient in Yuen Long data sample

Chapter 5: Empirical results and interpretations

In the following chapter, empirical results of the model will be presented and discussed. The model for the Tuen Mun data sample will be firstly discussed. Following the Tuen Mun data sample, the Yuen Long data sample will be interpreted.

5.1 Empirical result overview

5.1.1 Tuen Mun model:

Equation:

$$RPRICE = ß_0 + ß_1 AGE + ß_2 AGE^2 + ß_3 BLOCKS + ß_4 BLOCKS^2 + ß_5 DIST + ß_6 DIST^2 + ß_7 FLOOR + ß_8 FLOOR^2 + ß_9 SIZE + ß_{10} SIZE^2 + ß_{11} AS + ß_{12} CS + ß_{13} OS$$

The Ordinary Least Square (OLS) estimates of the equation are shown in Table 9. The included observations after adjusting endpoint in the Tuen Mun data sample are 3886. White's standard errors were used to deal with the problem of heteroskedasticity.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGE	-3.95×10^{-6}	6.35×10^{-7}	-6.219733	0.0000*
AGE^2	1.92×10^{-8}	2.19×10^{-9}	8.784422	0.0000*
BLOCKS	0.000511	1.71×10^{-5}	29.91114	0.0000*
$BLOCKS^2$	-3.19×10^{-5}	1.25×10^{-6}	-25.47048	0.0000*
DIST	-2.46×10^{-5}	1.69×10^{-6}	-14.57803	0.0000*
$DIST^2$	2.25×10^{-8}	1.83×10^{-9}	12.26790	0.0000*
FLOOR	2.36×10^{-5}	2.31×10^{-6}	10.23927	0.0000*
$FLOOR^2$	-4.14×10^{-7}	6.35×10^{-8}	-6.522903	0.0000*
SIZE	-7.09×10^{-6}	1.07×10^{-6}	-6.651073	0.0000*
$SIZE^2$	6.98×10^{-9}	1.11×10^{-9}	6.284928	0.0000*
AS	0.000117	2.03×10^{-5}	5.786509	0.0000*
CS	0.000111	1.96×10^{-5}	5.668228	0.0000*
OS	-0.000165	3.31×10^{-5}	-4.985489	0.0000*
C	0.009234	0.000280	32.96045	0.0000*
R-squared	0.584309		F-statistics	418.5546
Adjusted R-square	0.582913		Prob (F-statistics)	0.000000

Notes: *significant at the 1 per cent significant level

Table 9: OLS regression result for the Tuen Mun data sample

The result generated in the Tuen Mun data sample is consistent to what I expected in terms of the sign of the coefficient. For those which are marked as UNKNOWN in expected coefficient sign in the previous chapter, $DIST^2$; AS and CS gave a positive sign in front of their coefficient while DIST gave a negative sign. They will be discussed one by one at later stage. Here the general interpretation of the result will be put forward. First of all, the explanatory power of the model is satisfactory. The adjusted R-square, which determines the explanatory power of a model, is about 0.58. This number indicates the model can explain 58 per cent of the variation in the dependent variable (that is the property price per square foot). There is still room for improvement in the selection of data and independent variables.

A large number in F-statistic gives confidence in the overall significance of a model. It also indicates the significance of the regression model by looking at the p-value of F-statistics. The p-value of the F-statistics is 0.000000. It is less than the critical value of 1% significant level (0.01), It re-affirms all the included explanatory variables are relevance.

The critical value in t-statistics at the 95 per cent confident level is 1.96 and the critical value in t-statistics at the 99 per cent confident level is 2.575. The result shows all the magnitude in the t-statistic of the associated independent variable is larger than the critical value. All the coefficients of the independent variables are not only significant at 5 per cent significant level, but also 1 per cent significant level.

5.1.2 Yuen Long Model

$$RPRICE = ß_0 + ß_1AGE + ß_2AGE^2 + ß_3BLOCKS + ß_4DIST + ß_5DIST^2 + ß_6FLOOR + ß_7FLOOR^2 + ß_8SIZE + ß_9SIZE^2 + ß_{10}AS + ß_{11}CS + ß_{12}OS$$

The Ordinary Least Square (OLS) estimates of the equation are shown in Table 10. The included observations after adjusting endpoint in the Yuen Long data sample are 4098. White's standard errors were used to deal with the problem of heteroskedasticity.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGE	-6.83×10^{-6}	9.72×10^{-7}	-7.022189	0.0000*
AGE^2	3.48×10^{-8}	4.82×10^{-9}	7.216234	0.0000*
BLOCKS	0.011220	0.007909	1.418573	0.1561
DIST	0.000626	0.000432	1.448271	0.1476
$DIST^2$	-1.32×10^{-6}	9.14×10^{-7}	-1.440354	0.1498
FLOOR	2.20×10^{-5}	2.22×10^{-6}	9.906628	0.0000*
$FLOOR^2$	-2.78×10^{-7}	5.40×10^{-8}	-5.155010	0.0000*
SIZE	6.18×10^{-6}	5.14×10^{-7}	12.01829	0.0000*
$SIZE^2$	-4.38×10^{-9}	4.21×10^{-10}	-10.40310	0.0000*
AS	0.000362	4.03×10^{-5}	8.968923	0.0000*
CS	0.000339	4.35×10^{-5}	7.799821	0.0000*
OS	0.000152	5.42×10^{-5}	2.811464	0.0050*
C	-0.082807	0.058883	-1.406293	0.1597
R-squared	0.671962		F-statistics	697.3189
Adjusted R-square	0.670998		Prob (F-statistics)	0.000000

Notes: *significant at the 1 per cent significant level

Table 10: OLS regression result for the Yuen Long data sample

The sign of coefficients of the independent variable are compatible to what the previous chapter expected except the SIZE attribute. For the sign of coefficient which can not be proved previously, the empirical result has given an answer to them. DIST, AS and CS are positive in the sign of coefficient and $DIST^2$ is posted with a negative sign of coefficient.

R-squared and the adjusted R-squared in Yuen Long regression model are higher than the Tuen Mun regression model. They are about 0.672 and 0.671 respectively. At about 67 per cent variation of the dependent variable (property price per square foot) can be referred to the model's prediction. It is a satisfactory model but still has room for improvement in terms of the selection

of data and independent variables.

F-statistics is an indicator to show the significance of the whole model but not the individual attribute. A large figure in F-statistics and correspondingly low p-value of F-statistics confirmed the significance of the Yuen Long regression model. The p-value of F-statistics (0.000000) in Yuen Long regression model is lower than 0.01. It suggests the overall significance of the Yuen Long regression model is significant at 1% significant level.

The significance of a coefficient always relates to the critical value of t-statistics. 1.96 and 2.575 are the critical value at 95 per cent confident level and 99% confident level respectively. All the coefficients of independent variables in the Yuen Long regression model are significant at 99 per cent confident level except BLOCKS, DIST and $DIST^2$. The coefficient of these three independent variables do not fall within 95 per cent confident level and even do not fall within 90 per cent confident level (the critical value of 90 per cent confident level is 1.645).

5.2 Impact of different independent variables on unit property price

As assumed by the OLS regression model, independent variables are not correlated. So the level of inference of an independent variable on the dependent variable is fully reflected on its coefficient. Different independent variables will be presented in the following.

5.2.1 Continuous independent variables

i. AGE

In both the Tuen Mun and Yuen Long regression models, they present a negative coefficient in first order independent variable (AGE) and a positive coefficient in the second order independent variable (AGE^2). This indicates the inference of the age of a residential property price is negative but with a decreasing rate of decrease. The inference is like the law of diminishing which is in line with what is expected in the previous chapter.

The above phenomenon can be explained. Although the age of a building will have a negative impact on the residential property price, a residential property price can never reach zero in Hong Kong. The land value which occupied a very large portion of a residential property value never disappears as the demand exists. So, mathematically speaking, an opening upward quadratic polynomial with no real roots can plot the phenomenon. Thus this spells out the arrived result in the regression for the age-attribute.

The magnitude of coefficient between Tuen Mun and Yuen Long regression model is different. Age of a residential property in Tuen Mun affect mildly (coefficient for AGE is -3.95×10^{-6} and for AGE^2 is 1.92×10^{-8}) than that in Yuen Long (coefficient for AGE is -6.83×10^{-6} and for AGE^2 is 3.48×10^{-8}). This is because the average residential property age in Tuen Mun is higher than that in Yuen Long. Tuen Mun is entering the later stage of the law of diminishing.

ii. BLOCKS

The result of the estate effect, measuring by the number of building block in an estate as a proxy, is significant in Tuen Mun data sample but not in Yuen Long. The insignificance in this coefficient in Yuen Long data sample is possibly due to insufficient of sample estate involved in the data sample.

The positive coefficient in the first order of the independent variable provides evidence to support the presence of estate premium. It is believed that facilities provided by a larger estate are better and more than a smaller estate. The positive effect by the BLOCKS attribute reduces as the number of blocks in an estate increase. The facilities may reach a saturated level even the number of blocks in an estate increases. Shopping arcades; club house facilities and amenity facilities do not have much difference as the abovementioned increased. A concluding summary for this attribute is likely that there is an estate premium for existence of facilities such as shopping arcade; club house and amenity area, but the difference of estate premium between a larger estate and a smaller estate which both of them provide similar amenity facilities do not differ sharply. So the attribute of the number of blocks in an estate has positive impact on the unit property price but with a decreasing rate of increase.

iii. DIST

In terms of significance of the coefficient of independent variable for the

distance to the nearest West rail station, the regression model in Yuen Long data sample fails to reject the null hypothesis which the coefficient is equal to zero. Insignificance of the station distance attribute may fall within the reason which the entire data sample is not very far away from the West rail station. The farthest direct distance to the Yuen Long West rail station in the Yuen Long data sample is 500 meters while the minimum direct distance is 50 meters (refers to table 5). At most a 10 minutes' walk can reach the farther sample estate from Yuen Long West rail station.

In Tuen Mun regression result, it displays a decline in unit residential property price when the direct distance between the residential property and the West rail Tuen Mun station increases. And, unit property price increase if such distance further increase. It seems the presence of Tuen Mun West rail station brings upward the nearby residential property price. However, the effect here may be due to the presence of bus terminal next to the Tuen Mun West rail station. The effect brought by the bus service can not be separated in this attribute. So, the result concludes there is an increase in unit residential property price when distance between the station location and residential property increase only. There is no implication on Tuen Mun West rail station to the unit residential property price.

iv. FLOOR

The attribute of floor level in both Tuen Mun and Yuen Long regression model are significant. And, they show a similar coefficient figure. The coefficient of first order independent variable in both districts is positive and the coefficient

of second order independent variable is negative. The unit residential property price increases when the floor level increases. But the increase rate is not a constant; it is subject to a decreasing rate of increase.

To explain this result, live science can help. It has been identified that low floor level suffer mainly noise pollution disregarding the view the apartment can provide. As noise level inversely proportion to the square of distance, noise generally has been decreased at a very low level when the floor level reached 20^{th} floor or above. At the same time, the outside view varies from the floor level too. But again, the outside view enjoyed by the higher floor level such as 20^{th} floor or above is similar; the effect of outside view diminishes among the higher floor level. Therefore, the price indication by the regression result is reasonable.

v. SIZE

The size of a residential property has a negative impact on its unit price in Tuen Mun regression model. The unit residential property decreases with a decreasing rate of decrease as its size increases. This is compatible to the expectation in the previous chapter. The reason for this is relating to the pricing strategy against the size of a residential property. It may be a pricing strategy that the unit price for the larger flats is slightly lower than that of a much smaller flat.

However, it is not the case in the Yuen Long regression model. Contrary to the result in Tuen Mun regression model, the size of a residential property has a

positive impact on its unit price in Yuen Long. The results show the unit residential property increases with a decreasing rate of increase as its size increases. The appeared counter-intuitive may be due the young property age in Yuen Long residential properties. The mean property age in the Yuen Long data sample is about 15 months. The inference of speculation is high in the young age properties. Then the different pricing strategy to that in Tuen Mun may appear.

5.2.2 Dummy independent variables

i. AS

Both the regression result in Tuen Mun and Yuen Long model show a significant and positive figure in the coefficient of announcement stage (AS). The existence of announcement effect can be deduced. Differences can also be noticed on the regression results. Premiums of HK$0.000117 and HK$0.000362 per unit price (real price per square foot) are willing to pay to the residential properties near to the subject Tuen Mun West rail station and Yuen Long West rail station respectively.

As the announcement of the West rail project generated future prospect in the accessibility gain in the area, a higher premium measured in Yuen Long regression model implies people has a higher expectation on the accessibility to be gained by the West rail station in Yuen Long. This implication is pointing to the issue on railway alignment. The regression result supports the statement that a relatively direct railway alignment, comparing with the vehicular

roadway, starting from Yuen Long to CBD gives people a higher expectation. They expect the time cost or the cost in monetary terms will decrease for going to CBD when the West rail starts operate. In the same rationale, a non-direct railway alignment starting from Tuen Mun to CBD makes less attractive to people. Expecting a lower gain in accessibility turns the expectation premium lower than that in Yuen Long case.

ii. CS

Construction stage dummy variable in two regression models are significant. They show a same result pattern to that in announcement stage which Tuen Mun regression result shows a lower coefficient figure to that of Yuen Long regression result. The coefficient of the construction stage dummy variables in Tuen Mun and Yuen Long are 0.000111 and 0.000339. About three times larger in terms of impact to the unit price of residential property is found in between Yuen Long and Tuen Mun. Such difference is due to the reason of different expectation to Yuen Long and Tuen Mun West rail station. This has been discussed in AS attribute above.

In the construction stage of the West rail project, still it is subject to the expectation by the people to the West rail. By adding the nuisance effect generated from the construction period, the coefficient of the construction stage dummy variable, nevertheless, is a positive figure. It can reasonably conclude that the expectation of the future accessibility gain inference more than the construction nuisance generated.

What finding specifically observed in the construction stage dummy variable is the decline in the coefficient magnitude from announcement stage dummy variable (AS) to construction stage dummy variable (CS). In the Tuen Mun regression model, the difference between AS-coefficient and CS-coefficient is 6×10^{-6}. In the Yuen Long regression model, the different between AS-coefficient and CS-coefficient is 2.3×10^{-5}. The magnitude decline would be interpreted as capitalization of the nuisance was generated from the construction period. As construction period will generate an unpleasant environment for living, residential property price drop is expected, so as in the CS-coefficient comparing with AS-coefficient.

iii. OS

The operation stage dummy variable (OS) resulted with a significant but negative coefficient in Tuen Mun regression model. The coefficient tells us that the prices of residential property near Tuen Mun West rail station drop HK$ 0.000165 per square foot comparing with the time when there was no West rail station.

On the other hand, a significant and positive coefficient is found from the result of Yuen Long regression model. An increase of HK$ 0.000152 per square foot to the residential property price near Yuen Long West rail station is generated comparing with the no-West-rail-station period.

The above result can be jointly explained. Railway generally introduces two major impacts to local residents. The first one must be the accessibility gain.

The second one is the nuisance generated from the railway. The second impact is a sunken impact which every railway station will bring to the neighborhoods. Then, the positive or negative effect brought by the railway station mainly depends on the impact of accessibility gain. The accessibility gain in between the railway station to the CBD is at especially important as the majority of people travel between these two locations for work. By studying the map, the non-direct railway alignment in West rail connecting Tuen Mun to the CBD reduces its impact of accessibility to be gained in connecting the local resident to the CBD. A faster mean of mass public transportation connecting to the CBD can actually be found in Tuen Mun district. Therefore the impact of accessibility by the Tuen Mun West rail station reaches a very low figure to the residential property prices nearby. It is a figure even lower then the magnitude of nuisance effect. So a negative coefficient of operation stage dummy variable in Tuen Mun regression model is reasonable when considering together with the nuisance effect by the railway station. Contrary to the situation in Tuen Mun, Yuen Long West railway station doesn't have the problem of non-direct railway alignment on the map. Gain in accessibility by the West rail is expected. As Hong Kong people is quite time conscious, the gain in accessibility will well cover the nuisance effect. The positive coefficient of operation stage dummy variable in Yuen Long regression model is sensible.

Chapter 6: Conclusion

6.1 Conclusion of the study

"Time is money" is used to describe Hong Kong peoples' attitude towards time. Given the high costs of owning a private car, the majority of population prefers to use public transportation. As the accessibility of a site location relative to the CBD determines its value (Haig, 1926), the accessibility provides by the public transportation impacts on the residential property price.

In order to minimize the cost of construction, the usual principle is that a railway will be directly aligned to the preferred destination. In the case of West rail, the alignment of the track is interesting since the prime consideration is transportation linkage. The policy decision on aligning the rail track is to provide railway access to new towns. So the railway is designed to link as many new towns as possible. The railway alignment decision was intended to strike a balance between a business point of view and corporate social responsibility. The country park acts as a physical barrier to Tuen Mun district. The situation is further complicated by the existing country park. The final decision resulted in a non-direct railway alignment from Tuen Mun West rail station to the urban area. Therefore the study examines two West rail stations, Tuen Mun and Yuen Long, which provide an example of inefficient and efficient railway alignment respectively.

An empirical study of residential property price indicates the efficiency of railway

alignment affect the price of nearby residential properties. After the railway system became operation in December 2003, those residential properties adjacent to Tuen Mun West rail station suffered a negative impact. However, the residential properties which are adjacent to the Yuen Long West station experienced a positive impact on the property price after work commenced. The major difference between Tuen Mun and Yuen Long West rail stations is the railway alignment relative to the CBD i.e. Given the locations of the towns, the railway alignment from Tuen Mun to the CBD detours from the most direct route whilst that from Yuen Long to the CBD does not.

The research concludes that the efficiency of a railway, in terms of the railway alignment, affects the nearby residential property prices in Hong Kong. If the railway alignment in the transportation network gives a non-direct alignment relative to the CBD direction, a negative inference on the residential property price will appear as in the Tuen Mun West rail station case. However, if the alignment of railway is laid in usual which is relatively direct to the CBD direction, a premium will be added to the price of residential properties which located nearby the station. This is similar to the case in Yuen Long West rail station.

6.2 Limitations of the Study

A number of limitations exist in this study. They are the indication level of the study, the data limitation and the selection of independent variables.

Firstly, the study includes two stations for testing the impact of inefficient railway alignment to the residential property price. The intermediate stations between the two subject stations have not been studied. The study can visualize there is a

negative impact to the residential property price when there is a detour in railway alignment to the CBD comparing with the vehicular roadway. However, there is no indication to the degree of negative impact against the level of inefficiency of railway alignment on a proportional basis. As a result, there is a room for improvement for detailing the relationship between level of inefficiency of railway alignment and its price indication to the residential property price.

Secondly, it is also talking about the indication power of the regression result. The regression result is fully generated from the Hong Kong data. It can reflect the situation in Hong Kong but not necessarily transferable to other foreign countries. This is because the factors such as the adaptability of using public transportation and population density will vary from city to city. So, the result in this study may not be applied to other cities in foreign countries.

Thirdly, in order to create a level ground for making comparison, the data used in the regression model are deflated by the price indices issued by the Rating and Valuation Department (RVD). As the price index is produced from a set of sample buildings, there is a limitation in this price index as a means to represent all the building price fluctuation in Hong Kong. Inaccuracies may incur when the nominal price is deflated into the real price by the price index when running the regression.

Finally, not all the independent variables are included in both the regression model in Tuen Mun and Yuen Long. This is for the reason of strategically keeping the regression model simple while maintaining its reasonable predicting power. On the other hand, some data have not been included because they are not available. For example, the orientation of the property may affect the residential property price

especially in Hong Kong. Hong Kong people tend to choose a flat with windows pointing to the south. Another example is about the actual flat size compared to saleable floor area ratio. The lower the ratio, the better the property layout and hence it can be given a higher property price.

6.3 Areas for further study

The result which indicated that a station located on a non-direct railway alignment to CBD when compared to the roadway will produce a negative impact to the nearby residential property is satisfactory enough in Hong Kong. However, there are rooms for improvement to enrich the study.

First of all, as mentioned in the limitation of the study, the result generated can be said it only represents Hong Kong situation. The hypotheses in this study have not been tested in the foreign countries and cities. So, empirical result in foreign countries and cities is necessary to get the full picture of the empirical result generated here.

Next, the data sample used to prove the result is from a heavy rail system (i.e. KCRC). It is an interesting issue to see that whether the result in this study applies to other type of railway system. For example, whether a station on a non-direct railway alignment in Light Rail (LR) system compared with the roadway will produce a negative impact to the nearby residential property? Another example, will the same result in the study appear when station is on a non-direct inter-province railway alignment? All of these are pointing to the adaptability of the result in this study to various type of railway transportation and this is a further study area for this

research.

Last but not least, Tuen Mun area is still an interesting area to be studied. A lot of models predict a value of site by using its accessibility to the CBD as an indicator. This study has found the failure of efficient railway implementation and the buses service remains the major public transportation connecting Tuen Mun to the CBD. It should induce another topic on relation to the importance of buses service to Tuen Mun district.

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Appendix

Appendix I: Name of sample estate/ building and its location

Tuen Mun

Sample building:

- Tuen Mun Town Plaza
- Kam Wah Garden
- Tai Hing Garden Phase I
- Tai hing Garden Phase II
- Hong Lai Garden

Yuen Long

Sample building

- Shun Fung Building
- Sun Yuen Long Center
- Yoho Town

Appendix II: Monthly Domestic price indices by class (Territory- wide)

Year/Month		Class A	Class B	Class C
1995	1	109.9	109.9	110.8
	2	113.9	112.4	109.8
	3	114.2	112.9	112.7
	4	114.7	111.2	112.0
	5	110.8	109.4	111.5
	6	110.4	106.0	108.8
	7	108.5	105.0	104.9
	8	108.0	102.4	105.4
	9	104.5	99.6	99.9
	10	103.5	99.1	98.9
	11	105.4	102.0	100.6
	12	106.3	102.7	102.9
1996	1	106.9	104.7	102.0
	2	109.1	108.6	107.2
	3	112.2	114.5	109.2
	4	112.1	112.4	110.9
	5	113.3	113.5	114.2
	7	115.4	114.0	114.2
	6	114.7	114.8	117.1
	8	116.8	118.5	116.4
	9	119.0	117.7	117.0
	10	122.4	123.3	124.0
	11	127.1	128.2	129.1
	12	132.5	135.2	136.5
1997	1	137.9	143.6	148.8
	2	151.1	154.6	160.6
	3	160.6	162.4	167.1
	4	154.5	157.8	162.1
	5	169.5	173.7	175.3
	6	171.0	171.0	177.7
	7	165.1	166.7	174.4
	8	168.8	170.5	180.2
	9	170.2	169.1	174.3
	10	171.1	172.1	178.7
	11	161.2	157.0	166.9
	12	155.4	153.4	160.0
1998	1	145.2	141.0	148.9
	2	138.5	134.6	136.2
	3	140.4	137.9	137.4
	4	135.5	133.4	136.3
	5	129.4	126.2	128.2
	6	114.0	111.7	110.0
	7	110.2	105.9	110.6
	8	106.3	104.3	102.1
	9	100.4	96.8	99.6
	10	96.6	95.1	95.2

	11	100.7	100.4	99.1
	12	105.0	105.0	103.5
1999	1	103.9	103.9	105.0
	2	103.0	101.7	102.8
	3	102.4	102.2	99.1
	4	102.7	101.8	101.4
	5	103.1	103.1	102.6
	6	103.3	101.5	101.8
	7	101.8	101.4	100.0
	8	99.3	101.3	100.5
	9	96.8	97.0	98.0
	10	95.5	95.7	96.5
	11	93.2	94.5	95.1
	12	94.9	95.8	97.1
2000	1	96.6	97.5	98.4
	2	96.2	98.0	98.2
	3	93.2	95.8	97.6
	4	92.4	93.8	96.8
	5	89.0	89.9	92.1
	6	84.5	85.6	89.5
	7	86.0	86.2	88.0
	8	86.0	87.1	88.1
	9	87.4	88.0	88.6
	10	86.5	86.4	88.1
	11	81.3	84.1	85.5
	12	80.2	81.6	83.7
2001	1	78.9	80.5	83.4
	2	78.7	80.0	83.0
	3	80.5	82.3	83.9
	4	81.9	81.4	84.6
	5	79.0	80.5	83.8
	6	78.7	81.3	85.3
	7	78.7	80.5	81.8
	8	76.7	79.1	78.8
	9	75.9	77.5	78.1
	10	72.7	74.4	75.7
	11	71.9	74.0	75.2
	12	72.3	74.1	75.5
2002	1	72.6	74.5	75.7
	2	73.4	73.7	74.3
	3	71.9	73.6	74.3
	4	70.4	72.7	74.3
	5	69.4	73.7	73.9
	6	69.4	72.6	74.3
	7	69.0	71.4	72.3
	8	66.9	68.1	70.6
	9	64.1	67.5	68.4
	10	64.0	64.7	68.7
	11	62.9	64.9	68.8
	12	62.7	64.9	67.0

2003	1	61.5	63.4	67.2
	2	61.0	63.8	66.5
	3	60.0	60.6	64.3
	4	59.4	59.8	64.1
	5	58.2	59.3	63.3
	6	57.3	59.2	62.6
	7	56.6	58.3	61.1
	8	56.8	58.5	60.8
	9	59.1	60.2	65.5
	10	61.3	62.5	68.6
	11	62.1	63.6	69.5
	12	63.2	64.4	70.0
2004	1	66.4	68.8	75.4
	2	69.2	72.4	81.5
	3	72.9	77.1	89.0
	4	73.4	79.2	89.3
	5	72.8	76.4	87.4
	6	69.7	73.9	83.2
	7	70.0	74.0	83.9
	8	73.1	76.4	87.8
	9	74.7	80.5	91.2
	10	77.6	83.2	95.8
	11	75.9	81.6	95.1
	12	76.4	82.6	94.1
2005	1	78.6	84.5	98.9
	2	81.6	89.4	102.1
	3	87.6	94.0	108.7
	4	88.5	94.5	110.2
	5	87.2	95.0	112.3
	6	85.9	91.8	108.4
	7	84.9	92.2	109.3
	8	86.3	93.9	106.5
	9	86.7	93.3	109.9
	10	85.8	90.5	107.1
	11	82.5	87.5	102.1
	12	83.7	89.5	103.6
2006	1	84.1	90.7	105.0
	2	84.3	90.9	106.0
	3	86.6	91.8	108.3
	4	86.6	92.9	109.8
	5	87.6	93.1	110.1
	6	86.0	91.4	107.8
	7	85.7	91.2	106.4
	8	87.3	91.5	106.8
	9	87.6	91.8	108.1
	10	87.3	91.5	108.1
	11*	87.0	90.8	109.5
	12*	87.8	91.0	109.0

* Provisional figures

Source: Rating and Valuation Department, Hong Kong Property review